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ST. LAWRENCE RIVER ENVIRONMENTAL INVESTIGATIONS

VOLUME 4

ASSESSMENT OF WATER AND SEDIMENT QUALITY IN THE CORNWALL AREA OF THE ST. LAWRENCE RIVER, 1985

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ASSESSMENT OF WATER AND SEDIMENT QUALITY IN THE CORNWALL AREA OF THE ST. LAWRENCE RIVER, 1985

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FOREWORD

Environment Ontario's investigation of water, sediment and effluent in the Cornwall/Massena area of the St. Lawrence River in 1985 has been provided as background information for the development of the St. Lawrence River Remedial Action Plan (RAP) and the Cornwall MISA Pilot site report currently under preparation. The data collected from these studies has also been used for the following:

- "St. Lawrence River Environmental Investigations Volume: 2, Environmental Quality Assessment of the St. Lawrence River in 1985 as reflected by the Distribution of Benthic Invertebrate Communities", Griffiths, 1988.

- "St. Lawrence River Environmental Investigations Volume: 5, Hydrodynamic and Dispersion Characteristics of the St. Lawrence River in the vicinity of Cornwall/Massena", Nettleton, report in preparation.

- Assessment of Courtaulds Effluent for the development of a 1987 Control Order

- "An Assessment of Existing Information regarding PCB's in the Cornwall/Massena section of the St. Lawrence River", Environment Canada, 1988.

Recommendations from this report and further investigations are being dealt with under the St. Lawrence River (Cornwall) Remedial Action Plan and the MISA Pilot site investigation.

ACKNOWLEDGEMENTS

This study was designed and field work supervised by Y. Hamdy of the Great Lakes Section, Water Resources Branch.

The author acknowledges the efforts of the Great Lakes Section's field personnel in the collection of samples and the efforts of the Water Quality Inorganic Trace Contaminants and Pesticides Laboratory Sections in the analysis of these samples.

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Synopsis

In 1985, the Ontario Ministry of the Environment (MOE) conducted a series of environmental surveys to evaluate the impact of local discharges on the environmental quality of the St. Lawrence River. This report summarizes water and sediment quality in the Cornwall/Massena section of the St. Lawrence River. Effluent data were also collected in 1985 to identify the impact of local discharges on sediments and water. Statistical analyses were performed to compare 1979 and 1985 sediment quality.

Water Quality

1. Total phenols (4-Aminoantipyrene reactive) were found in concentrations above the Provincial Water Quality Objective (PWQO of 1 ug/L to protect against the tainting of edible fish flesh) in 94% of water samples collected near effluent discharges in the Cornwall section (north channel) of the St. Lawrence River.

   Low levels of the speciated phenolics, vanillin and acetovanillone were detected downstream of Domtar. These compounds are typically found in association with pulp-mill effluents. In addition, phenol was detected at river stations near the Domtar discharge (below the 300 ug/L EPA objective).

   Neither 2,4,6-trichlorophenol nor pentachlorophenol, two compounds detected in water samples from the north channel and Domtar effluent in 1979, were detected in 1985.

   Recommendation:

   Use of the 4AAP test for total phenols is a non-specific test which measures the concentration of a collection of phenolic compounds, including those that occur naturally (formed during the breakdown of

plant matter). This procedure therefore, has limited value in assessing industrial discharge effects. **Further studies should identify the speciated phenolic compounds and their concentrations should be directly related to their individual significance in terms of toxic effects or tainting properties.**

The existing PWQO for total phenols is also of limited value given that it is based on tainting and taste thresholds for mono and dichlorophenols which may or may not be present in the 4AAP test results. **Reassessment of the PWQO for total phenols and Water Quality Objective development for speciated phenols should continue with an aim to determine better criteria to measure impacts in the environment. In addition, laboratories must develop the analytical capability for improved measurement of these compounds.**

2. Detectable levels of organosulphur compounds in samples collected near Courtaulds/BCL and volatile compounds in samples collected near Domtar/CIL/Cornwall Chemicals were well below any available criteria. Levels above the PWQO for zinc (30 g/L) were observed in 32% of the water samples collected near the Courtaulds/BCL outfall. Based on zinc concentrations in Courtaulds/BCL effluent, it is clear that Courtaulds/BCL is a significant source of zinc to the St. Lawrence River.

   Recommendation:

   Discharges of zinc from Courtaulds/BCL should be reduced to levels which would allow the receiving water to meet the PWQO.

Sediment Quality

3. Using sediment results for 26 comparable stations in 1979 and 1985 no significant difference was observed for particle size, PCB's, iron, zinc, mercury, cadmium, copper, lead, total phosphorus and total Kjeldahl nitrogen (TKN).

Recommendation:

Further studies and analyses aimed at determining long-term trends should concentrate on collecting information from comparable locations (eg: stations lying within industrial/municipal effluent plumes should be assessed differently than stations reflecting general ambient conditions; sites with similar grain size characteristics, such as depositional areas, would reduce grain size effects on contaminant concentrations).

4. The Provincial dredging guidelines (Persaud & Wilkins, 1976) for nutrients (total phosphorus and total Kjeldahl nitrogen), oils and greases, total PCBs and all inorganic parameters, except for arsenic were exceeded at some stations in one or both of the north (Cornwall) and south (Massena) channels. The highest levels of most contaminants were observed near or downstream of Courtaulds/BCL. Forty percent of the sediment samples from the north channel exceeded the MOE guideline for mercury (300 ng/g) compared to 11% from the south channel. Except for total PCBs and iron, the average concentrations for all the above parameters were higher in the north channel than in the south channel.

   Average PCB levels were 135 ng/g along the south shore compared to 60 ng/g along the north shore. Although the percent exceeding the guideline (50 ng/g) were similar at 61% and 59% respectively, the maximum, total PCB concentration (13,750 ng/g) was found in the south channel near the General Motors plant. The maximum level for mercury (4.4 g/g) was observed in the vicinity of Courtaulds/BCL and was substantially lower than levels observed in previous years.

   Thirteen organochlorine pesticides were observed in sediment samples from the area at trace levels (near the detection limits). No active sources were indicated by the pesticide distribution observations.

5. The poor correlation between percentage of fine sediment and concentration of lead, mercury and zinc, as well as the spatial distribution of both grain-size corrected and bulk sediment results suggest that local sources, Courtaulds/BCL and Domtar/CIL/Cornwall Chemicals are contributing to contamination in the area. This is supported by effluent and water quality data also collected in 1985. In addition, benthic macroinvertebrate sampling indicated that Courtaulds/BCL effluent is contributing to degradation of the invertebrate community found near the outfalls (Griffiths, 1988).

Recommendation:

Stricter effluent controls should be implemented at:

Courtaulds/BCL - High concentrations of mercury, lead and zinc in sediment near Courtaulds/BCL represents ongoing and historical loadings. Effluent control for these contaminants is required as soon as possible to alleviate the possible toxic and bioaccumulative effects. The source of mercury within the plant (suspected to be mercury levels in caustic soda and/or sulphuric acid - raw materials purchased by Courtaulds for their process) should be identified and corrected (e.g. treatment or investigate other sources of raw materials).

Canadian Industries Limited (CIL) - Further loading reductions leading to the virtual elimination of mercury discharges from CIL should be effectively carried out in accordance with the goal of the Great Lakes Water Quality Agreement for persistent toxic substances. The federal requirement for mercury loadings from chlor-alkali plants should be reconsidered with an aim to encourage alternative technologies for producing chlorine.

6. The spatial distribution of grain-size corrected sediment data suggest that there are no significant local sources of arsenic, cadmium, chromium, iron or nickel. Elevated levels of these parameters at the mid-channel stations indicate that transport of these compounds is occurring from upstream.

Recommendation:

Upstream loadings of nutrients, metals and contaminants such as PCBs and mercury should be regularly measured and assessed in relation to the input to the system from local sources. Remedial measures to reduce impacts from Cornwall discharges should be implemented based on evidence collected using a mass-balance approach for contaminants of concern.

7. Due to the nature of the St. Lawrence River flow, water quality effects from local inputs at Cornwall/Massena are difficult to measure after dilution. Effluent monitoring is essential; in determining what those inputs are, and in maintaining control of discharge limits. Sediment sampling determines spatial patterns in contaminant concentrations and detects the influence of local sources. Biomonitors (indigenous or introduced) assist in determining the presence of active sources of contaminants, toxicity, and the bioavailability of contaminants from water and sediments. Sediment bioassays identify specific areas of contamination, toxicity and bioavailability. The use of macroinvertebrates in monitoring studies indicate the availability and movement of contaminants up the food chain. A fate and transport modelling approach enables all factors to be considered.

Recommendation:

A long-term monitoring program should be adopted focussing on an integrated approach including: effluent, water, sediment and biota sampling; recommending remedial actions as required.

1. INTRODUCTION

Cornwall, Ontario and Massena, New York are major industrial centres on the international section of the St. Lawrence River. Previous surveys (1979-1982) have identified municipal and industrial discharges on both sides of the river contributing to localized increases of a number of chemicals and contaminants to levels in excess of Provincial and Great Lakes Water Quality Agreement Objectives for the protection of aquatic life. In 1985, the Cornwall/Massena area of the St. Lawrence River was re-identified as a Great Lakes Area of Concern.

Since the 1979-82 surveys, various industrial and municipal plant modifications were carried out, discharge limits set and the need for further monitoring of trace organic and inorganic contaminants identified. In 1985, the Ministry of the Environment conducted a series of environmental surveys including effluent monitoring, water quality sampling, a sediment quality survey and an investigation of benthic community structure. The 1985 investigations were designed primarily to:

- update the 1979 sediment quality data;
- document existing sources of trace contaminants and assess their impact on the Cornwall area aquatic environment and water use;
- assess the effectiveness of plant modifications and effluent treatment by Domtar Fine Papers and other point sources and;
- to collect information relevant to further remedial measures at Courtaulds/BCL, CIL and Domtar Fine Papers.

The information collected also forms a basis for the Municipal and Industrial Strategy for Abatement (MISA) Pilot Site Investigation at Cornwall and serves as background information leading to the development of a St. Lawrence River Remedial Action Plan (RAP) for the Cornwall Area.

The 1985 investigations included effluent monitoring with accompanying sequential sampling of the water column at the combined outfalls of Domtar/CIL/Cornwall Chemicals and Courtaulds/BCL. Sediment sampling was

conducted throughout the portion of the St. Lawrence River stretching from the Grasse River to the downstream tip of St. Regis Island in Lake St. Francis (Figure 1). Both north and south channels were sampled for sediments and, where possible, benthic invertebrates were collected for identification, enumeration and the study of community distribution.

This report is intended to present sediment and water quality conditions in 1985 and to provide a comparison with 1979 conditions. In assessing the significance of contaminants, the Ontario Ministry of the Environment guidelines for open water disposal of dredged material are used as a reference. Water and effluent quality data also collected in 1985 are included to identify the impact of Domtar/CIL/Cornwall Chemicals and Courtaulds/BCL on water and sediments with respect to both Provincial and Great Lakes Agreement Water Quality Objectives.

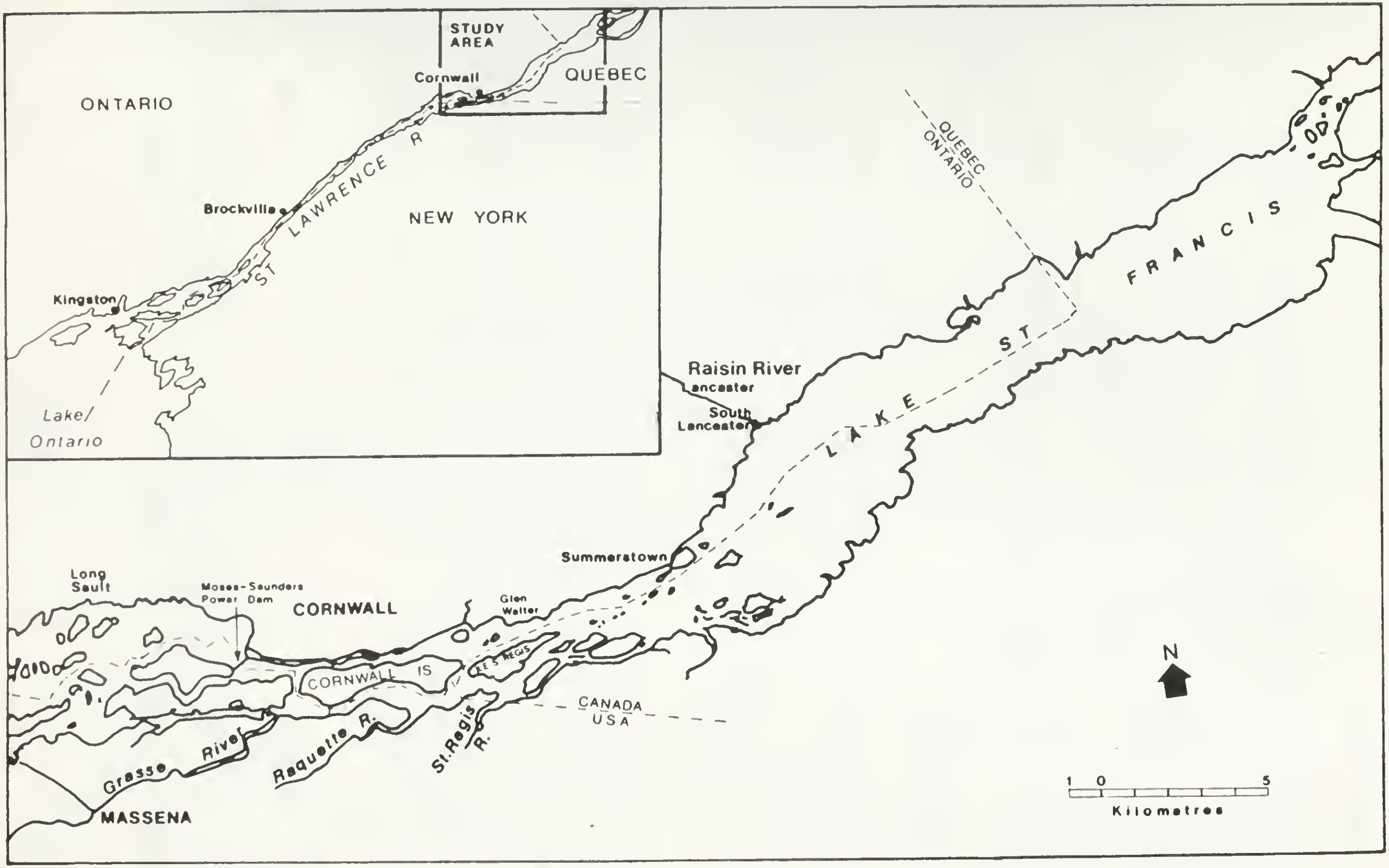

FIGURE 1 STUDY AREA

2. WATER USES

The St. Lawrence River supports a wide variety of water uses in the Cornwall-Massena area including; commercial navigation, hydroelectric power generation, municipal and industrial water supplies and waste disposal. The river is also used extensively for boating, fishing and swimming. A detailed description of water uses and potential sources of contamination is contained in "Assessment of Water, Sediment and Biota in the Cornwall, Ontario and Massena, New York Section of the St. Lawrence River 1979-1982 (Vol.1)" (Kauss et al., 1988). The following is intended to supplement and update information provided in the above MOE publication.

2.1 WATER SUPPLY

The City of Cornwall Water Treatment Plant (WTP) draws about 52,000 m^3/day (11.5 MIGD) from Lake St. Lawrence above the Moses-Saunders power dam (Figure 2). The capacity is 83,270 m^3/day (22 MIGD). Residences not serviced by the municipal water supply use ground water or, in the case of some cottages and homes along the shore, river water.

The two major industries in Cornwall, Domtar and Courtaulds-BCL, use a considerable volume of water for processing and cooling. The water used for cooling is discharged unchanged, except for an increase in its temperature. Water used in the process is discharged as process effluent. The total amount of water used at Domtar in 1985 was about 113,000 m^3/day while approximately 50,000 m^3/day was used at Courtaulds/BCL (pers. comm. R. Helliar). These amounts, together with that used by the City of Cornwall, account for about 2 per cent of the water flowing in the St. Lawrence River.

2.2 FISHING

Lake St. Francis is very heavily fished by sport anglers. Data obtained in a 1982 creel census indicates that the anglers using Lake St. Francis are predominantly local Ontario residents (75%). Anglers from Quebec form the

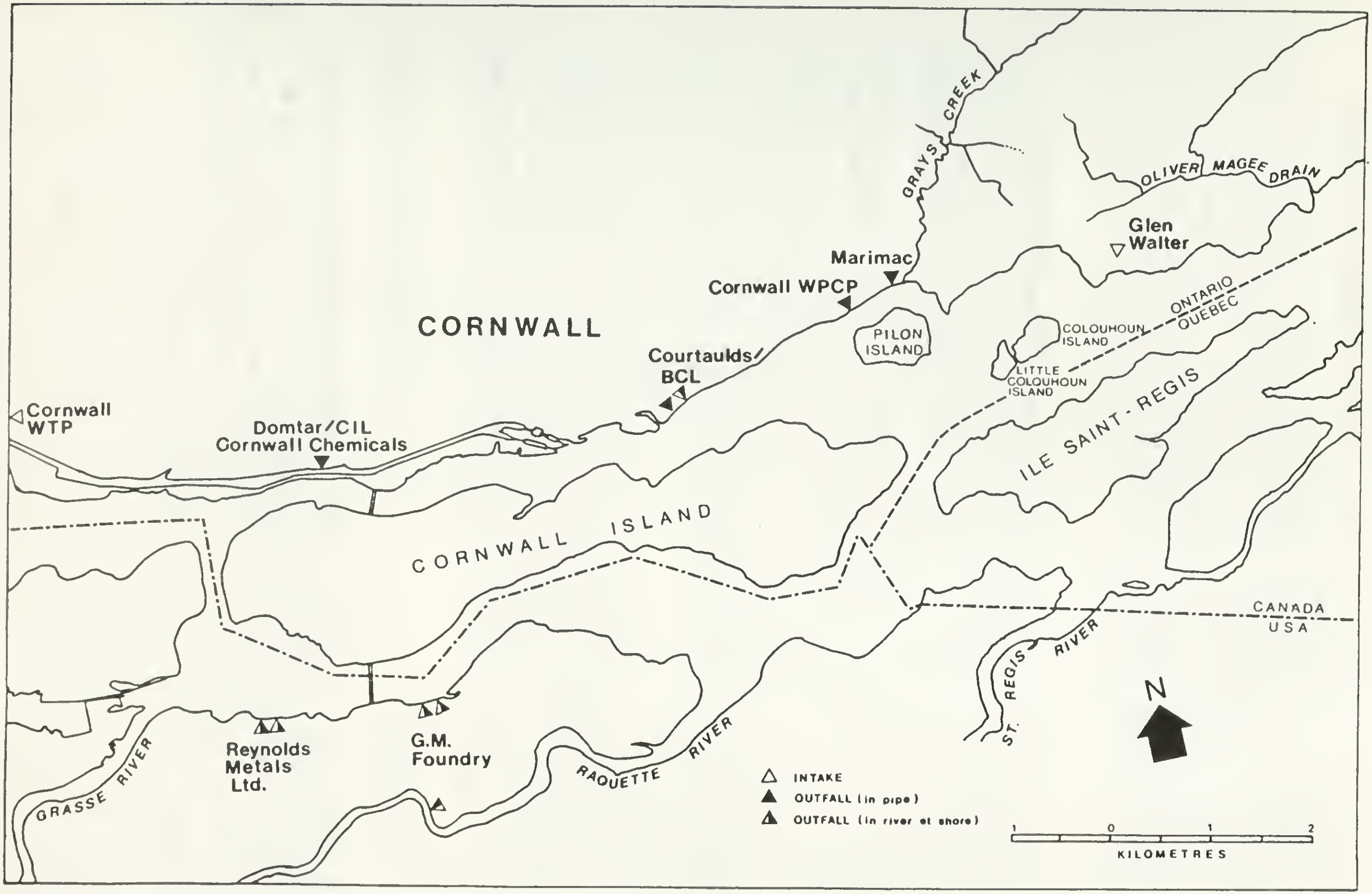

FIGURE 2: MAJOR INDUSTRY, INTAKES AND OUTFALLS IN THE CORNWALL-MASSENA REACH OF THE ST LAWRENCE RIVER

next largest group (18%), and non-local Ontario residents (5.6%) and non-residents (U.S.) (1.4%) comprise the remainder of anglers (Ontario Ministry of Natural Resources, 1987). Yellow perch is the preferred target species, with walleye (yellow pickerel), pike and smallmouth bass being of secondary importance. The recreational fishery in the Cornwall-Massena area has been impaired due to elevated levels of mercury, and fish consumption advisories for larger-sized fish in the Cornwall-Lake St. Francis area are in effect.

Commercial fishing for species such as brown bullhead, white sucker, sunfish, black crappie, American eel and carp has occurred in Lake St. Francis for several decades. The two factors controlling the fishery are contaminants and market restrictions. The bullhead, sunfish, white sucker and crappie fisheries have not been affected by contaminants restrictions, but price fluctuations have impacted the fishing effort directed toward these species. The carp and eel fisheries, have been subject to sporadic closures due to elevated levels of mercury and PCBs combined with the availability of foreign markets. All eels must be sold outside North America due to their PCB levels (Ontario Ministry of Natural Resources, 1987).

Fish from the St. Lawrence are an important source of protein for the Mohawks of Akwesasne. The Akwesasne fishery, involving between 20 and 40 participants, is for yellow perch and walleye, with estimated annual harvests in 1982 of 8,000 to 10,000 kg and 4,000 kg, respectively (Cornwall RAP, 1988).

2.3 RECREATION

Four designated swimming areas are located along the Ontario shore from Cornwall to the Quebec border, although nearly the entire shoreline is accessible for swimming and water sports. There are several marinas and waterfront cottages and homes dot the shoreline making recreational boating a popular activity in the areas downstream of Cornwall.

2.4 SHIPPING AND POWER GENERATION

Thousands of ships use the St. Lawrence seaway annually. The shipping channel generally follows the Ontario - NY border south of Cornwall Island and then passes between Cornwall and St. Regis Islands where the route continues along the Ontario-Quebec border and bisects Lake St. Francis. No maintenance dredging is required except at the Lancaster Bar - downstream of this study area in Lake St. Francis.

Ontario Hydro operates the Moses-Saunders Power Dam. The dam (in conjunction with the dam at Beauharnois at the outlet of Lake St. Francis) maintains water levels at strict limits (1 foot) however, flow rates and volumes do fluctuate (Cornwall RAP, 1988).

2.5 WASTEWATER DISCHARGE - ONTARIO POINT SOURCES

2.5.1 Ontario Point Sources

At the time of the survey, the primary Ontario inputs were the three direct industrial discharges of wastewater into the St. Lawrence River (Domtar Fine Papers/CIL/Cornwall Chemicals; Courtaulds and British Cellophanes Ltd. (BCL); and Marimac) as well as the City of Cornwall Water Pollution Control Plant (WPCP) (Figure 2). In 1988, Marimac's wastewater discharges were routed to the WPCP. Table 1 summarizes the average flow, discharge type, effluent treatment and effluent quality as related to the industrial or municipal activity for each of the primary Ontario point sources.

Domtar/CIL/Cornwall Chemicals:

The combined outfall from Domtar/CIL/Cornwall Chemicals is the largest discharge of industrial wastewater by volume in Cornwall. Most of the flow is from Domtar Fine Papers, with about 113,000 m^3/day, compared to about 3140 m^3/day from CIL in 1985.

TABLE 1: CORNWALL POINT SOURCE DISCHARGES TO THE ST. LAWRENCE RIVER, 1985

Company	Domtar Fine Papers Ltd.	Canadian Industries Ltd. (CIL)	Cornwall Chemicals Ltd.	Courtaulds (Canada) Ltd.	British Cellophane Ltd. (BCL)	Marimac Inc. (formerly ITEA)	Cornwall W.P.C.P.
Activity	- Fine paper is made from logs and chips by the Kraft pulping process and from purchased pulp.	- The mercury cell process is used to produce caustic soda and chlorine gas.	- Industrial chemicals such as as hydrosulphide, hydrochloric acid, carbon tetrachloride and carbon disulphide are manufactured from the caustic soda and chlorine produce at CIL.	- Dissolving sulphite pulp is reacted to form rayon.	- Viscose supplied by Courtaulds is made into cellulose film.	-Polyester sheer drapery fabric is produced.	- Municipal and industrial waste streams are treated.
Average flow (m^3/day)	- 113,000	- 3,140	- 850[1]	- 5220	- 4090	-2,800[1]	- 47,670
Discharge Type	- Continuous through a common multi-part diffuser outfall extending 76m into the river.			- The combined sulphide sewer and Courtaulds viscose sewer discharge continuously via an alkaline diffuser extending 244 m into the river. The acid sewer discharges via an acid diffuser outfall extending 244 m into the river.		-Wash waters were discharged into the river via a submerged outfall 62.5 m from shore. -Marimac is presently connected to the Cornwall WPCP (Aug. 1988)[1].	- Continous via a 607 m long, submerged diffuser outfall located southwest of Pilon Island.
Effluent treatment	- Primary using a clarifier.	- All mercury - contaminated streams are collected and treated to remove mercury before discharge.	- Effluent is clarified before discharge.	- No external effluent treatment.		-No external effluent treatment.	- Primary treatment equipped with phosphorus removal and use of a clarifier.
Effluent Quality	- The soluble component of the effluent contains low concentrations of resin and fatty acids, and chlorinated and non-chlorinated phenolic compounds. - A production-based total suspended solids was to become effective June 30/87; a request for extension is under review. - The installation of a lime mud spill control was to be complete by Sept. 30/86; a request for extension is under review.	- Meets Federal Fisheries Act regulations governing the amount of mercury discharged from chlor-alkali plants.	-Effluent contains significant concentrations of chloroform and carbon tetrachloride.[2]	- Out of compliance for BOD_5 for existing requirements based on an expired Control Order. - Revised requirements will be set when a new control order is issued.	- Total acidity and BOD_5 not in compliance in 1985; presently suspended solids and BOD_5 are in compliance although periodic excesses of sulphuric acid still occur.	-high BOD and low suspended solids. -MOE 1987 data shows Marimac to be a minor contributor of organic compounds.	- BOD not in compliance in 1985.
		- Contains low levels of suspended solids and dissolved solids.		- The combined acid sewer is characterized by low pH, BOD and suspended solids, and high concentrations of zinc (originating from Courtaulds). - The sulphide and viscose sewers are characterized by PH's in the 10-12 range and relatively high BOD's but low suspended solids. - The sewers contain low levels of organic compounds. - The three final sewers (sulphide, acid and viscose) were sampled during 1985 and tested by aerated, 96-hr rainbow trout bioassays. The LC 50's were 0.5, 2.2 and 28.3%, respectively.			

Source: MOE, 1985

[1] Personal communication, B. Hellier, DMOE

[2] DOE, 1985

The Domtar plant blends pulp made on site (hardwood bleached kraft) with purchased pulp (hardwood and bleached softwood kraft) to produce fine and specialty grade papers. Domtar's effluent is relatively high in BOD (biochemical oxygen demand) due to dissolved organic waste material from the pulping of wood into paper. Suspended solids, in the form of lime, clay and wood fibre, and total phenols are also present in relatively high levels. Most of the Domtar effluent undergoes primary treatment; however, a low suspended solids stream which contains odorous condensates bypasses the clarifier and joins the main effluent stream before discharge to the St. Lawrence River (pers. comm. R. Helliar).

Canadian Industries Limited (CIL) produces chlorine and sodium hydroxide by electrolysis using the mercury cell process. Liquid effluent that is, or could be, contaminated with mercury is collected and treated to remove it. The CIL effluent continues to meet the Federal Regulation for mercury from chlor-alkali plants (0.0025 kg/tonne of chlorine produced).

Secondary industrial chemicals such as sodium hydrosulphide, hydrochloric acid, carbon tetrachloride, and carbon disulphide are manufactured by Cornwall Chemicals. The effluent is clarified before discharge. Significant quantities of carbon tetrachloride and chloroform have been found in the Cornwall Chemicals effluent (Environmental Protection Service, 1985).

Courtaulds - British Cellophanes Limited:

Courtaulds Canada Ltd. and its associated company, British Cellophanes Ltd. (BCL), operate adjacent factories which discharge through common sewers. Courtaulds produces rayon fibre and supplies BCL with viscose for making cellophane. Three of the main sewers: the acid, the sulphide and the storm sewer start at BCL, while the viscose sewer discharges wastes generated only at Courtaulds. BCL discharges some of its once-through cooling water to a city storm sewer, while the remainder is discharged to the St. Lawrence River through a storm sewer. The Courtaulds acid recovery plant generates cooling and condensate water which is discharged through the acid recovery sewer, Caravelle Carpets (closed 1981) sewer, and the

Tank Car unloading sewer. The combined acids sewer discharges via a diffuser located about 800 feet from shore (Figure 2). This waste is characterised by low pH, BOD, and suspended solids and high concentrations of zinc from Courtaulds. Overall, the process sewers contain relatively low levels of organic compounds. (Department of Environment, 1985: Ontario Ministry of the Environment, 1986).

Marimac Inc. (formerly Itea):

Marimac opened in the early 1980s and manufactures polyester sheer draperies. The wastewater generated by washing newly-woven material is characterized by high BOD and low suspended solids. The effluent was discharged through an outfall (no diffuser) 62.5 metres from shore. Marimac expanded its operation in mid-1984 and early 1985. MOE effluent testing in 1985 found consistently high BOD levels. (Ontario Ministry of the Environment, unpublished data). Marimac was connected to the Cornwall WPCP in 1988 and no longer discharges directly to the river.

Cornwall Water Pollution Control Plant (WPCP):

The Cornwall WPCP, a primary facility, was expanded from about 38,000 m^3/day to about 50,000 m^3/day in 1988. Most of the sewers in the older sections of Cornwall are combined. During spring run-off and storm events, there were numerous bypasses from the sewer system directly to the St. Lawrence River (pre 1988). The number of bypasses has been reduced by the addition of storage along with the expansion of the WPCP. The Pitt St. and Amelia St. combined sewers no longer existed in 1985. The influent to the WPCP includes three major industrial effluent: BASF, a phthalic and maleic anhydride producer: Pfizer Canada, a citric acid producer; and Champion Industries, a producer of animal-grade feed whey. Marimac was added in 1988. BSAF and Pfizer both have secondary treatment systems.

2.5.2 Ontario Non-Point Sources:

The Raisin River, which drains most of the area from Cornwall to Lancaster (Figure 1), receives some storm drainage from the north end of the city, leachate from the now-closed City of Cornwall landfill site, and relatively high levels of nutrients from agricultural drainage. This river flows roughly parallel to the St. Lawrence River and discharges into it at Lancaster, downstream of the study area. The St. Lawrence River shoreline is well populated with homes and cottages using septic systems. There is some discharge of private wastewater directly to the river.

2.5.3 New York State Point Sources:

There are four main sources on the south shore of the St. Lawrence River near Massena: General Motors Central Foundry, Reynolds Metal Company, the Aluminum Company of America and the Massena Sewage Treatment Plant. (Figure 2).

General Motors Central Foundry:

This plant manufactured cast aluminum automotive products. A closed-loop system is employed at the foundry for process and effluent water with discharge to the St. Lawrence River through two outfalls. A Stormwater collection lagoon discharges to the Raquette River (Kauss et al., 1988).

Until 1973, a PCB-based hydraulic fluid was used in some of the die casting machines. An extensive stormwater and groundwater monitoring program was undertaken during 1983-1985 near the GM landfill and PCB-contaminated sludge pits to investigate PCB levels (General Motors Remedial Investigation Report, 1986). PCB-contaminated leachate from the landfill site was observed to be moving towards the river. The site has been capped temporarily until further remedial investigations are completed. The main facility discharge has generally met the state pollution discharge elimination system (SPDES) permit level of a maximum of 2 g/L PCBs since 1984. A revised permit limiting PCBs to non-detected levels (at a detection limit of 0.065 g/L) is presently being proposed.

Reynolds Metal Company:

The Reynolds aluminum reduction plant discharges to the St. Lawrence River through three separate outfalls: process water, non-contact water, and sanitary sewage. Sampling in September 1980 by the New York State Department of Environmental Conservation (NYSDEC) found no detectable levels of PCBs in either the process or intake waters. In the summer of 1988 however, the DEC established that Reynolds Metals was discharging PCBs with its permitted wastewater discharges. A revision to the existing SPDES permit is being proposed for this facility as well as limiting PCBs to non-detected levels (det. limit, 0.065 ug/L).

The Aluminum Company of America:

The Aluminum Company of America (ALCOA), as well as the Massena Sewage Treatment Plant, discharge indirectly to the St. Lawrence River via the Grasse River. The ALCOA plant is involved in the reduction, casting, and manufacture of ingot, wire rod and bar products. The total plant wastewater is stabilized in a series of lagoons including one for sanitary wastes. All major non-sanitary wasteflows are then directed to the secondary lagoon for treatment prior to discharge to a point in the Grasse River approximately 10 km upstream of the river mouth. Grasse River sediments are highly contaminated with PCBs from historic ALCOA discharges (Kauss et al., 1988). Presently, the company has reduced PCB levels in its wastewater to less than 2 ug/L. A proposed SPDES permit revision at all three industrial discharges will limit these levels to non-detected levels (at a detection limit of 0.065 ug/L).

Massena Sewage Treatment Plant:

The Massena STP is an upgraded secondary treatment facility which discharges to Grasse River and subsequently to the St. Lawrence River. No phosphorus controls are required at this plant, as with all sewage treatment facilities in New York State discharging to the St. Lawrence River.

3. METHODS

3.1 Sample Collection

Sample handling and preservation were performed as outlined in "A Guide to the Collection and Submission of Samples for Laboratory Analysis" (Ontario Ministry of the Environment, 1985).

Water

Water samples (1.5 m. depth) were collected on June 18, 1985 from the Canadian section of the St. Lawrence River, downstream of the Courtaulds/BCL discharge (stations located on transects 367, 368, 369 and 394) (Figure 3). On June 19, all stations were sampled except those on transect 369. The vicinity of the Domtar Fine Paper diffuser (transects 361, 362, 363, 364, 395, 396 and 397) was sampled again on June 20. Samples near industrial outfalls were collected within a two hour period and repeated at least three times during the survey day. This sampling strategy was aimed primarily at collecting the necessary information for input to hydrodynamic and dispersion models reported in another Ministry document entitled "Hydrodynamic and Dispersion Characteristics of the St. Lawrence River in the vicinity of Cornwall/Massena (Vol. 5)" (Nettleton, report in preparation). These data are included in this report as a summary and to aid in the interpretation and discussion of sediment quality findings.

All water quality samples were analyzed for conductivity, total reactive phenols (4AAP), fluorides (except stations 369 and 369A) and pH. The area downstream of Courtaulds/BCL was sampled for zinc, sulphates and organosulphur compounds. A volatiles scan was performed on samples collected from stations 361 and 362 (with duplicates), 364, 365, 369, and 397 on June 20. Station 361 samples taken on June 20 were also analyzed for speciated phenolics.

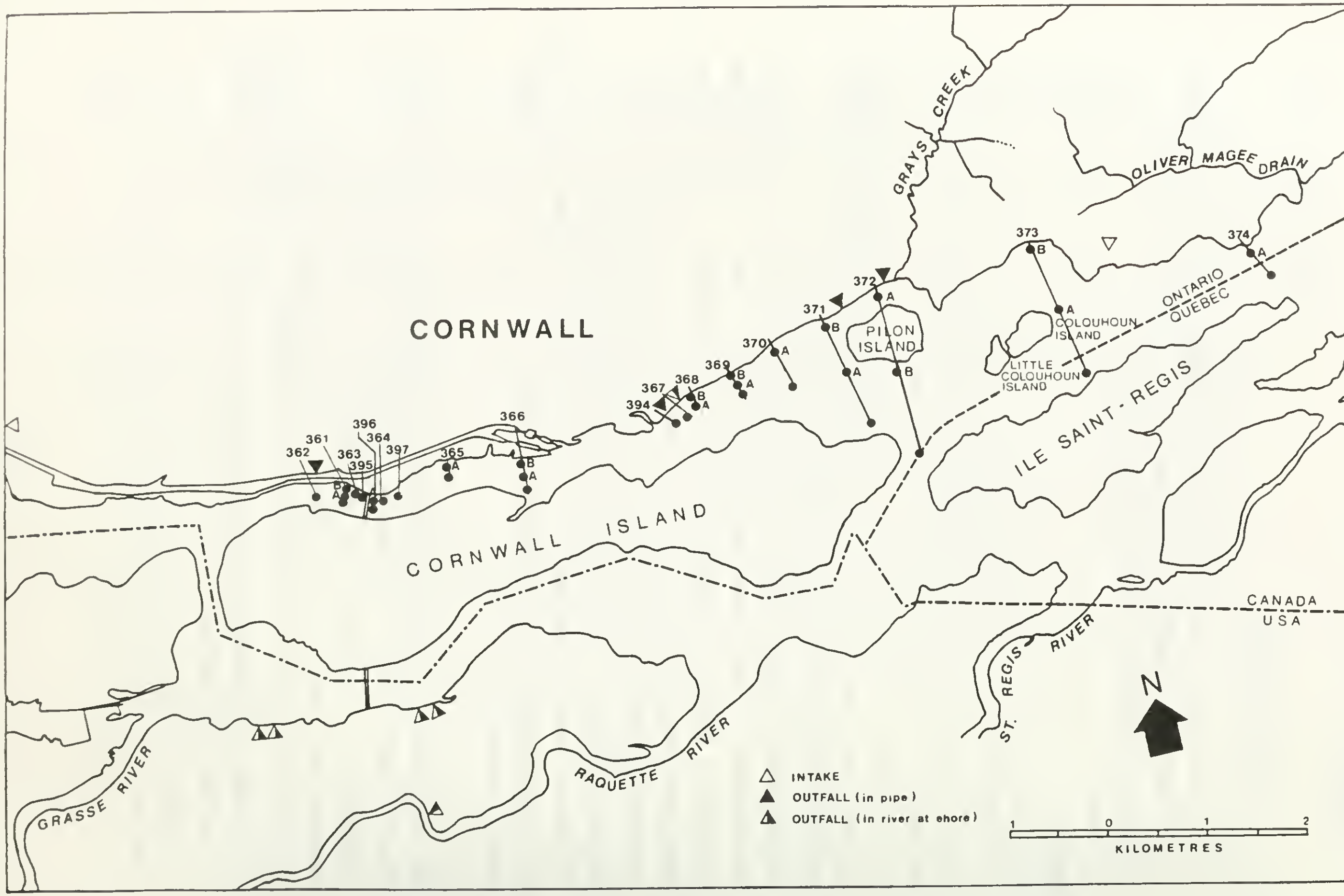

FIGURE 3: 1985 Water Quality Sampling Locations

Effluent

A seven hour composite sample and three two-hour composite samples were collected daily between June 18-20, 1985 from the Domtar Fine papers intake and final effluent, respectively. The samples were analyzed for total phenols, speciated phenols, organcis, total PCBs, and metals (iron, arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc). The Courtaulds intake and the acid, sulphide and viscose sewers were also composite-sampled and were analyzed for organics, nutrients, hydrogen sulphide, carbon disulphide, pH and metals (listed above).

Sediments

Sediment sampling was conducted from July 1 to 12, 1985 by taking a composite of the top 3 cm of three Shipek grabs at each station (Figure 4). Samples were analyzed for particle size distribution, nutrients (total phosphorus, total Kjeldahl nitrogen), total organic carbon (TOC), oils and greases, inorganics (aluminum, cadmium, chromium, copper, iron, lead, mercury and zinc), PCBs (total), and organochlorine pesticides (aldrin, dieldrin, alpha-BHC, beta-BHC, gamma-BHC, alpha-chlorodane, gamma-chlordane, DDT and its metabolites, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene (HCB), mirex, and endosulophan I & II.

3.2 LABORATORY ANALYSES

All chemical analyses were performed by the Ontario Ministry of the Environment laboratories in Rexdale, Ontario in accordance with the methods described in the "Handbook of Analytical Methods for Environmental Samples" (Ontario Ministry of the Environment, 1983).

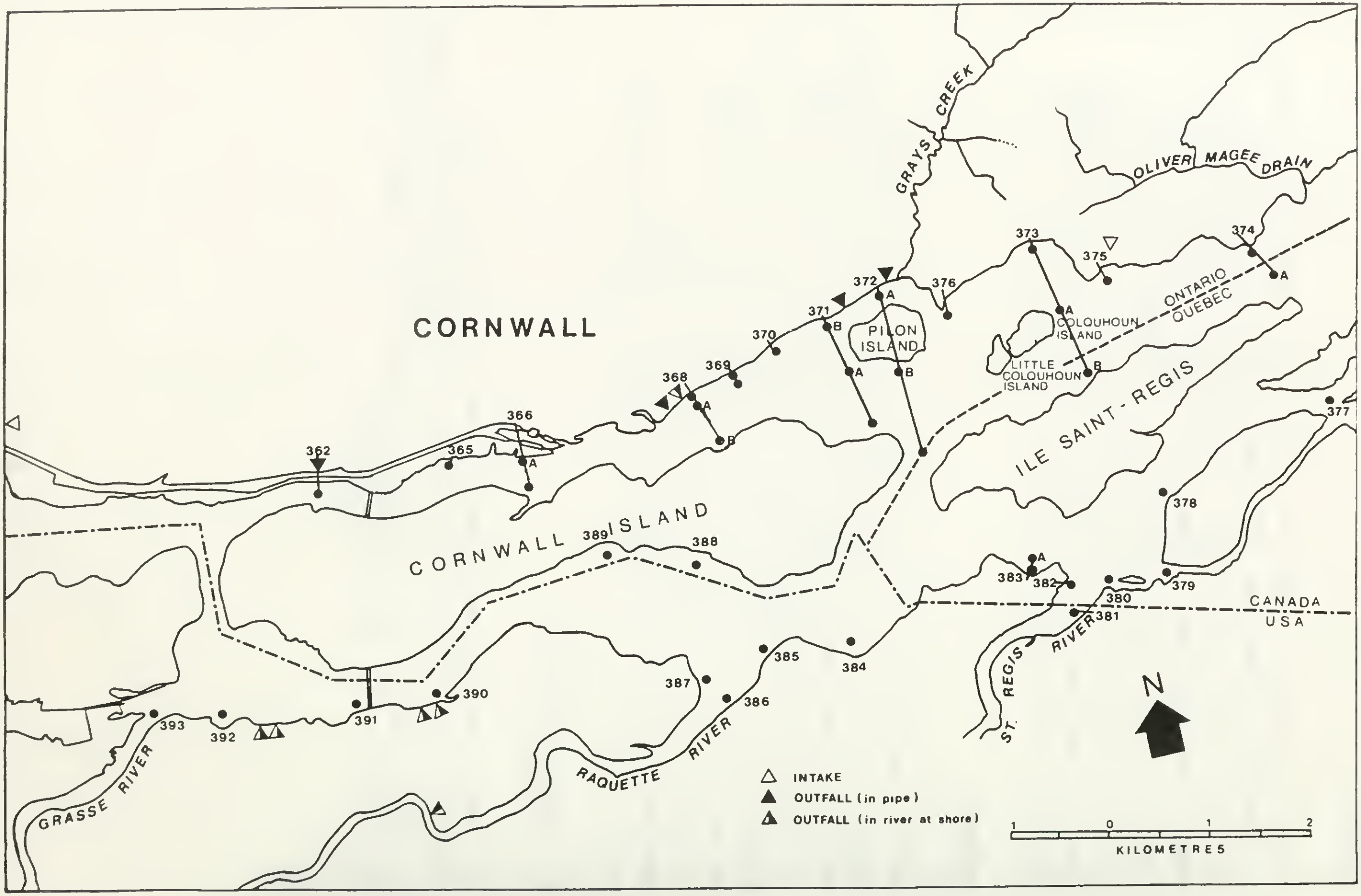

FIGURE 4: 1985 Sediment Quality Sampling Locations

4. RESULTS AND DISCUSSION

4.1 Effluent Quality

Results of the effluent and intake water monitoring are provided in Appendix Tables I and II. This data is presented to support the discussion of contaminant sources and their impact on the aquatic environment. Concentrations of mercury and copper in intake water are higher than expected for the St. Lawrence River. These samples were likely contaminated during sampling. Additional follow-up sampling is underway.

4.2 Water Quality

All water sampling was performed with the specific objective of determining the dispersion characteristics of the effluent plumes as they enter the St. Lawrence River via the combined outfalls of Domtar/CIL/Cornwall Chemicals and Courtaulds/BCL. Hence these samples were taken primarily in the vicinity of direct discharges and do not reflect overall ambient river conditions.

Water quality results for the north channel in the St. Lawrence River at Cornwall are summarized in Table 2. Results for individual stations are contained in Appendix Tables III to V. Open water quality results were compared with the Provincial Water Quality Objectives where available. The highest conductivity, sulphate and fluoride levels in water were found near the Courtaulds/BCL outfall, station 367 (Figure 3). However, these levels are within the normal range for Great Lakes surface waters and similar to 1979 survey results (Kauss et al., 1988). There are no Provincial Water Quality Objectives for these parameters.

In the Cornwall section of the St. Lawrence River, Domtar is a continuing source of total phenols (Appendix Table I). Total phenolics (4AAP reactive) were found in concentrations above the Provincial Water Quality Objective (PWQO) (Ontario Ministry of the Environment, 1984) of 1 ug/L (for

TABLE 2: SUMMARY OF CHEMICAL WATER QUALITY RESULTS IN THE (NORTH CHANNEL) AT CORNWALL, 1985

PARAMETER	PWQO	MRA	MEAN	MAX	MIN	S.D.	%>PWQO	%>MRA	N
Phenolics (µg/L)	1	0.2	3.89	24.2	ND	3.63	94	99.99	197
Conductivity (µmho/cm)	-		322.7	447	315	16.26		100	197
Sulphates (mg/L)	-		30.39	107.86	25.25	11.48		100	60
Fluorides (mg/L)	-		0.13	0.14	0.11	0.008		100	81
Zinc (mg/L)	0.03		0.049	0.440	0.001	0.083	32	100	60
trans, 2 Dichloroethylene (µg/L)	-	0	ND	2	ND	-		7	28
Chloroform (µg/L)	1200#	0	ND	11	ND	-		7	28
1,1,1 Trichloroethane (µg/L)	5300*	0	ND	4	ND	-		7	28
Toluene (µg/L)	60#	0	ND	27	ND	-		7	28
Tetrachloroethylene (µg/L)	310*	0	ND	3	ND	-		18	28
Phenol (ng/L)	600*	0	4	69	ND	-		57	7
Vanillin (ng/L)	-	0	ND	8	ND	-		43	7
Guiacol (ng/L)	-	0	5748	40,000	30	-		100	7
Acetovallinone (ng/L)	-	0	7	11	ND	-		71	7
Carbon Disulphide (µg/L)	1000#	.03	0.13	0.60	ND	-		86	21
Dimethyl Sulphide (µg/L)		.03	ND	0.09	ND	-		67	21

* EPA Objective (24 hr average)

\# OMOE Interim Guideline

MRA - Minimum reportable amount

SD - Standard deviation

%> MRA = % detected

- Number of samples

mean = median for parameter with ND's

Phenolics - only one ND, set equal to detection limit calculation of mean value.

Guaiacol - 40,000 ng/L (40 µg/L) result for station 361B

Speciated Phenolics - analysis withdrawn for many of the stations

the prevention of fish tainting and taste and odour problems in water) in 1985. All of the samples taken near Courtaulds/BCL exceeded the Objective; however, the highest concentrations were found at Station 366 B (24.2 ug/L) downstream of the CIL/Domtar/Cornwall Chemicals complex, and around and downstream of Pilon Island (max 23 ug/L).

Many phenolic compounds are more toxic than pure phenols. Thus, as recommended in Ontario Ministry of the Environment Report "The Significance of Phenolic Compounds in Ontario's Water" (de Barros, 1984), PWQO's for a number of individual phenolic compounds, some based on tainting thresholds (monochlorophenols and dichlorophenols) and others based on acute toxicity (trichlorophenol, tetrachlorophenols and pentachlorophenol) were adopted by the Ministry of the Environment.

Analysis for speciated phenolics was only performed on samples taken along transect 361, immediately downstream of the Domtar/CIL/Cornwall Chemicals diffuser (Figure 3). Vanillin, acetovanillone, and phenol (hydroxybenzene) were detected in 3, 5 and 4 of the seven samples respectively. Guaiacol was detected in all of the 7 samples with a maximum concentration for 40 ug/L at station 361 B (Appendix Table V). There are presently no objectives set for guaiacol in water; however Shumway and Palensky (1973) reported a threshold level for fish tainting at 100 ug/L. The phenol concentrations (maximum 0.069 ug/L) were well below the U.S. Environmental Protection Agency (24 h. avg.) objective of 300 ug/L for controlling undesirable taste and odour qualities in ambient water (U.S. Environmental Protection Agency, 1980). Concentrations in the water column were low compared with concentrations in the effluent from Domtar/CIL/Cornwall Chemicals (Appendix Table I). It is clear that Domtar is a significant source of these speciated phenolics to the river.

Neither 2,4,6-trichlorophenol nor pentachlorophenol, two phenolic compounds identified in water samples from the north shore and Domtar effluent in 1979, were detected in 1985 sampling.

Samples from six of the transects were analyzed for volatiles (361, 362, 364, 365, 396, 397). Detectable levels of trans-1,2-dichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, chloroform and toluene were found at transect 361 near the CIL/Domtar/Cornwall Chemicals combined outfall (Table 2). Although high concentrations of chloroform were present in effluent from Domtar/CIL/Cornwall Chemicals and Courtaulds/BCL sulphide sewer, the concentrations in the receiving water did not exceed the interim guidelines of 1200 ug/L for chloroform and 60 ug/L for toluene, or the EPA objectives (24 h. avg.) of 5300 ug/L for trichloroethane and 310 ug/L for tetrachloroethylene. One sample from Station 362 upstream of Cornwall also contained tetrachloroethylene (1 ug/L) below the EPA objective. Concentrations of carbon tetrachloride were high in Domtar/CIL/Cornwall Chemicals effluent; however, it was not detected in the river. All these compounds tend to volatilize rapidly when entering the water column.

The organo-sulphur scan of samples from transects near the Courtaulds/BCL outfall (transects 367, 368, 369, and 394) showed detectable levels of carbon disulphide and dimethyl sulphide. The carbon disulphide concentrations (ND-0.60 ug/L) were well below the MOE interim guideline of 1000 ug/L. Effluent samples show Courtaulds/BCL as a source of these chemicals.

Water samples from the stations near the Courtaulds/BCL outfall (transects 367, 368, 369 and 394) were the only ones analyzed for zinc. The PWQO of 30 ug/L was exceeded in 32% of the water samples with a maximum of 440 ug/L at station 368. Courtaulds/BCL is clearly an important source of zinc to the St. Lawrence River. Effluent from the acid sewer is 2 orders of magnitude higher than intake water (Appendix Table II) and considerably higher than Domtar/CIL/Cornwall Chemicals effluent.

4.3 Bottom Sediment Characteristics and Quality

4.3.1 Physical Characteristics

Sediment particle size may have an important bearing on the determination of sediment contaminant level distribution due to the tendency for organic and inorganic contaminants to adsorb to the finer sediment particles (i.e. silt and clay particles less than 63 um in diameter).

Figure 5 shows the distribution of bottom sediment grain size in the Cornwall-Massena area. Appendix Table VII provides numerical data for the samples. The fast flow of the St. Lawrence River along the north shore has resulted in particle sorting in the mainstream, as indicated by a high proportion of larger particles in the channel downstream of the Domtar-CIL-Cornwall Chemicals diffuser outfall (Station 366), where over 90% of the particles were greater than 63 um in size. Farther downstream, a widening and deepening of the channel results in depositional areas containing sediments with high silt and clay content. At station 370, downstream of Courtaulds/BCL, over 90% of the particles were less than 63 um in size. In the south channel, over 90% of the particles were less than 63 um in size at the confluence with the Raquette River (387) and upstream of the Reynolds Metal Co. outfall (392). Silt and clay content was also high in sediment samples collected near the Reynolds Metal Co., the General Motors foundry, and downstream of the St. Regis River. Downstream of General Motors, the particle size increased in the south channel.

4.3.2 Sediment Quality

A summary of sediment chemistry results (dry weight basis) appears in Table 3 for the north channel and south channel. Results for individual stations are provided in Appendix Tables VIII to X. Sediment quality results were compared with the Provincial Guidelines for open water disposal of dredged material where available. These guidelines were not developed for this purpose but will be used until appropriate sediment quality guidelines are developed.

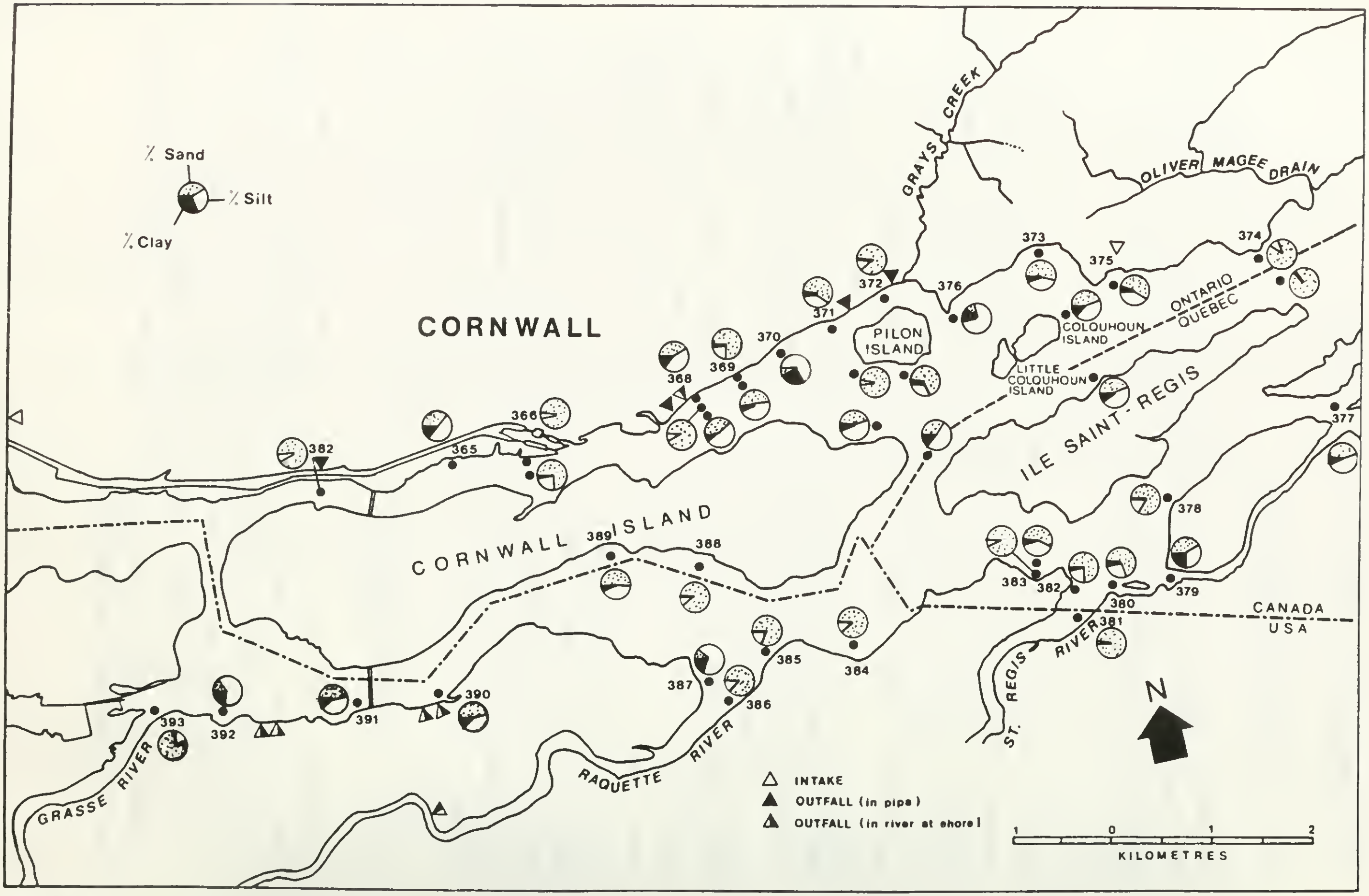

Figure 5: Sediment Grain Size Distribution in Bottom Sediments, St. Lawrence River, 1985.

4.3.2.1 <u>Nutrients</u>

The highest levels of total Kjeldahl nitrogen (TKN) were found in the north channel downstream of Courtaulds/BCL (max 4.7 mg/g) and around Pilon Island (max 5.1 mg/g). TKN concentrations above the Provincial guideline for open water disposal of dredged material (2.0 mg/g) were also found in samples from the vicinity of Reynolds Metals and General Motors, and from the mouth of the Raquette River on the U.S. side. Fifty-six percent of samples from the north shore exceeded the dredging guideline in contrast to 28% of the samples from the south shore.

Total phosphorus was found in concentrations above the Provincial dredged material disposal guideline (1.0 mg/g) near Reynolds Metals, at the mouth of the Raquette River, and near, and downstream of the Courtaulds/BCL outfall. In all, 10% of the samples had levels above the guideline with a maximum of 1.12 mg/g at station 392.

4.3.2.2 <u>Oils and Greases</u>

Data for oils and greases are summarized in Table 3. Results for individual stations are contained in Appendix Table VIII. Oils and greases (solvent extractables) were detected at concentrations above the Provincial dredging guideline (1500 ug/g) in 74% of sediment collected from the north shore, in contrast to only 33% of samples from the south shore.

Along the north shore, high concentrations were prevalent from downstream of the Domtar/CIL/Cornwall Chemicals diffuser to an area around St. Regis Island. A maximum concentration (16748 ug/g) was observed at station 368 near Courtaulds/BCL. Along the south shore, elevated concentrations of oils and greases were observed near Reynolds Metals outfalls, in the mouth of the Raquette River and in an area of sediment deposition downstream of St. Regis River (station 377). A maximum concentration (5479 ug/g) was observed in a sample collected near Cornwall Island (Station 388). Although it has not been confirmed through sampling, a likely source of

TABLE 3

SUMMARY OF SEDIMENT CHEMISTRY IN THE ST. LAWRENCE RIVER

PARAMETER	UNITS	PROVINCIAL DREDGING GUIDELINE	NORTH CHANNEL				SOUTH CHANNEL			
			MEAN*	SD	RANGE	%> GUIDELINE	MEAN	SD	RANGE	%> GUIDELINE
Total Phosphorus	mg/g	1.0	0.78	0.17	.43-1.09	8.7	0.65	0.25	.24-1.12	11.0
Total Kjeldahl Nitrogen	mg/g	2.0	2.2	1.4	.4-5.1	56.0	1.3	0.93	0.2-3	28.0
Oils and Greases	ug/g	1500	2918	3419	256-16748	74.0	1335	1284	12-5479	33.0
Arsenic	"	8.0	3.50	1.82	1.21-6.96	0.0	2.44	1.31	0.41-5.11	0.0
Cadmium	"	1.0	0.4	-	ND-1.3	8.7	0.25	-	ND-.98	0.0
Chromium	"	25	35.1	16.4	14-82	65.0	31.1	16	6.2-64	50.0
Copper	"	25	26.2	27.6	6.8-125	52.0	17	-	ND-63	28.0
Iron	"	10,000	12,922	3,507	6600-19000	74.0	13,600	5,925	5500-25,000	61.0
Lead	"	50	33.9	53	3.4-270	4.4	15	10.4	2.3-37	0.0
Mercury	"	0.3	0.55	0.9	.01-4.4	39.0	0.13	0.23	.01-.8	11.0
Zinc	"	100	319.7	771.7	19-3800	48.0	77	48.9	14-210	22.0
Nickel	"	25	14.9	8.3	5.50-37.00	4.3	11.7	6.8	2.20-26.00	5.5
PCBs, Total	ng/g	50	60	-	ND-1010	59.0	135	-	ND-13750	61.0
Aldrin	"		ND	-	ND-33	-	-	-	ND	-
Dieldrin	"		ND	-	ND-27	-	ND	-	ND-22	-
Alpha-BHC	"		-	-	ND	-	-	-	ND	-
Beta-BHC	"		-	-	ND	-	-	-	ND	-
Gamma-BHC	"		-	-	ND	-	-	-	ND	-
Alpha-Chlordane	"		ND	-	ND-12	-	-	-	ND	-
Gamma-Chlordane	"		ND	-	ND-12	-	-	-	ND	-
o,p-DDT	"		-	-	ND	-	-	-	ND	-
p,p'-DDT	"		-	-	ND	-	ND	-	ND-9	-
p,p'-DDD	"		-	-	ND	-	ND	-	ND-6	-
p,p'-DDE	"		ND	-	ND-6	-	ND	-	ND-2	-
Endrin	"		ND	-	ND-1	-	ND	-	ND-1	-
Heptachlor	"		-	-	ND	-	-	-	ND	-
Heptachlor Epoxide	"		ND	-	ND-10	-	ND	-	ND-10	-
Hexachlorobenzene	"		ND	-	ND-14	-	-	-	ND	-
Mirex	"		-	-	ND	-	-	-	ND	-
Endosulphan I	"		ND	-	ND-4	-	-	-	ND	-
Endosulphan II	"		ND	-	ND-10	-	-	-	ND	-
Endosulphan Sulphate	"		ND	-	ND-22	-	ND	-	ND-9	-

ND-Not Detected

*mean = median for samples with ND's

oils and grease on the north shore may be the oil tank storage area near Courtaulds. The significance of high concentrations of oils and greases on sediment biota has not been examined, but it is likely to have some impact on the benthic community.

4.3.2.3 Organic Contaminants

Total PCBs

Total PCBs are a concern in the Cornwall/Massena section of the St. Lawrence River because recreational and commercial fisheries have been impaired. Presently, PCB concentrations in sportfish from Lake St. Francis are within Health and Welfare Canada's unrestricted consumption guidelines (2 ppm or 2000 ng/g), however, PCB residues in young-of-the-year spottail shiners (*Notropis hudsonius*) collected from the Grasse River and the Cornwall area between 1979 and 1983 exceeded the Great Lakes Water Quality Agreement specific objective (100 ng/g) for the protection of fish-eating birds (Suns, K. et al., 1985).

In the Cornwall area, Domtar was found to be the largest contributor of PCBs in 1979 and 1980; however, no detectable levels (detection limit = 20 ng/L) were observed in Domtar effluent during 1985 sampling (Appendix Table I). Local PCB inputs in the Massena area are attributed to the Grasse River (the Aluminum Company of America), the Reynolds Metal Co. and the General Motors Central Foundry. In addition, upstream inputs from Lake Ontario may contribute to the elevated levels detected in the Cornwall/Massena section of the river.

In 1985, south channel sediment samples taken from the Grasse River mouth to the Raquette River mouth (Figure 6) contained the survey's highest levels of PCBs with values up to 275 times the MOE guideline (50 ng/g) for open water disposal of dredged material. The maximum concentration (13,750 ng/g) was found near the General Motors Plant at station 390. Some samples from the north channel also exceeded the guideline with the highest levels in the vicinity of the Courtaulds/BCL outfall (1,010 ng/g). Overall, 59%

of the samples from the north channel, and 61% from the south channel exceeded the guideline with detectable levels found up to approximately 7 km downstream of Courtaulds/BCL at Stn 374. Average total PCB concentrations were higher along the south shore (135 ng/g) compared to the north shore (60 ng/g).

Organochlorine Pesticides

Analytical results for organochlorine pesticides were most often below the laboratory detection limits. Thirteen pesticides (aldrin, dieldrin, α-and γ-Chlordane, p,p'-DDT, p,p'-DDD, p,p'-DDE, endrin, heptachlor expoxide, and endosulphan I, II & sulphate) were detected at trace concentrations near the detection limits (Table 3, Table IX). There are presently no objectives set for levels of these compounds in sediments.

No definitive upstream to downstream or cross-stream pattern emerges from these results. Trace levels of organochlorine pesticides in sediments may originate from agricultural run-off, tributary and upstream inputs.

4.3.2.4 Inorganic Contaminants

Table 3 summarizes the sediment inorganic contaminant results for the north and south channels in the study area. Table X contains the complete data set.

The Provincial Guidelines for open water disposal of dredged material were exceeded for chromium (25 ug/g) and iron (10,000 ug/g) in at least 50% of the samples taken from both the north and the south channels (Table 3). Guidelines were exceeded for copper (25 ug/g) in 41% of the samples from both channels. Sediment levels of arsenic in both channels and cadmium and lead in the south channel were within Ministry guidelines.

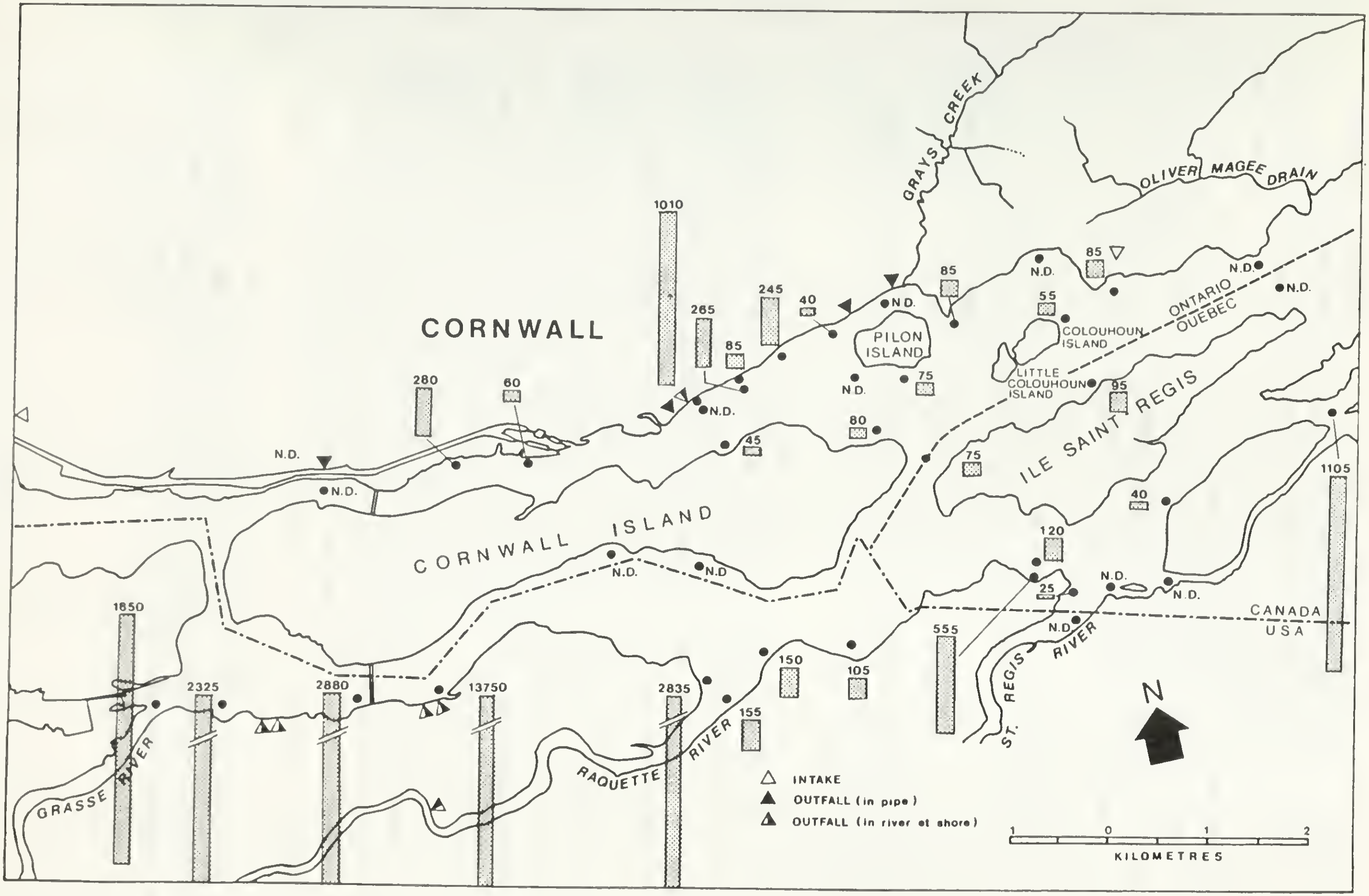

Figure 6 PCB Levels (ng/g) in Sediment from the Cornwall – Massena Reach of the St. Lawrence River, 1985

Except for iron, mean (or median) values for all inorganic contaminants were higher in the north channel than the south. The maximum levels observed for arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc were near or downstream of the Courtaulds/BCL outfalls. Zinc measured at Station 368 (near Courtaulds/BCL outfall) reached a level of 3800 ug/g in sediments reflecting the high levels of zinc in Courtaulds/BCL effluent. The Provincial guideline for dredged material disposal (100 ug/g) was exceeded in 48% of the samples from the north channel.

In the Cornwall-Lake St. Francis area of the St. Lawrence River, recreational and commercial fisheries have been impaired due to mercury discharges in the area. The elevated mercury levels may be attributable to the past use of mercury as a slimicide by Domtar (until 1970), the historic and present mercury discharges from CIL, discharges from Courtaulds/BCL, and discharges from other Cornwall industries to the St. Lawrence River via the Cornwall WPCP.

In 1985, 40% of the sediment samples from the north channel exceeded the MOE guideline for mercury (0.3 ug/g or 300 ng/g) compared to 11% for the south channel. The highest concentration (4,400 ng/g) was found 3 to 5 km downstream of CIL near the Courtaulds/BCL outfall (Stn 368) (Figure 7). Table 4 outlines a comparison of 1970, 1975, 1979 and 1985 mercury results for the north channel at Cornwall. Only comparable station locations were used to calculate a mean concentration for each of the arbitrarily designated sections downstream from the CIL discharge (Appendix Table XII) It is evident from this comparison that the variation in sediment mercury levels in a given area is extremely high, especially in the area 3 to 5 km downstream of CIL. This degree of variation restricts the conclusions that can be drawn from the data and precludes any trend analyses. However, it is worthwhile to note that the maximum levels observed in 1985 are substantially lower than those observed in previous years.

Sediment particle size may have an important bearing on the determination of sediment contaminant level distribution due to the tendency for organic and inorganic contaminants to sorb on to the finer sediment particles

(Forstner and Wittman, 1983). To minimize the effects of particle size on the assessment of sediment contaminant level distributions, the measured concentration was normalized to a fine particles (<63 um) content of 100%.

Correlation (r) and determination (r^2) coefficients for the percentage of fine sediments versus the concentration of inorganic parameters are provided in Appendix Table XI. The analysis included all 41 stations and was subsequently repeated omitting Station 368 (where the highest concentrations for most inorganics were observed). Scatterplots for each inorganic parameter versus fine particles are presented in Appendix Figures I to III. Both uncorrected (bulk) and corrected data for particle size for the inorganics are presented in Figures 8 to 10.

A significant linear correlation ($r>0.75$; $p<0.05$) was found between the percentage of fine particles and the levels of cadmium, chromium, copper, iron and nickel in sediment samples. Thus, the grain-size effects appear to explain a significant percentage of the variability associated with the spatial distribution of these contaminants in bottom sediments from the Cornwall-Massena area, suggesting that there are no major local sources for these parameters (with the exception of copper). This is supported by the spatial distribution of inorganic contamination in the corrected results (Figures 8 to 10) which is in contrast to that observed in the bulk sediment results: levels for arsenic, cadmium, chromium, iron and nickel observed at stations near local sources are generally not elevated above levels detected in the vicinity of station 362 which serves to represent upstream levels. The corrected results for copper show peaks at station 368 and 368A which are located directly below the Courtaulds/BCL outfall. This suggests that Courtaulds/BCL may be a source of copper; however, effluent data from Courtaulds/BCL do not show elevated levels of copper compared with copper concentrations in the intake water.

Levels do appear elevated above other areas at the mid-channel stations 371A and 374A. These elevated levels suggest that although the depositional areas in the Cornwall-Massena reach accumulate inorganics in the sediment, transport of these compounds in the main stream of the St. Lawrence River is also occurring. Interpretation of the results for

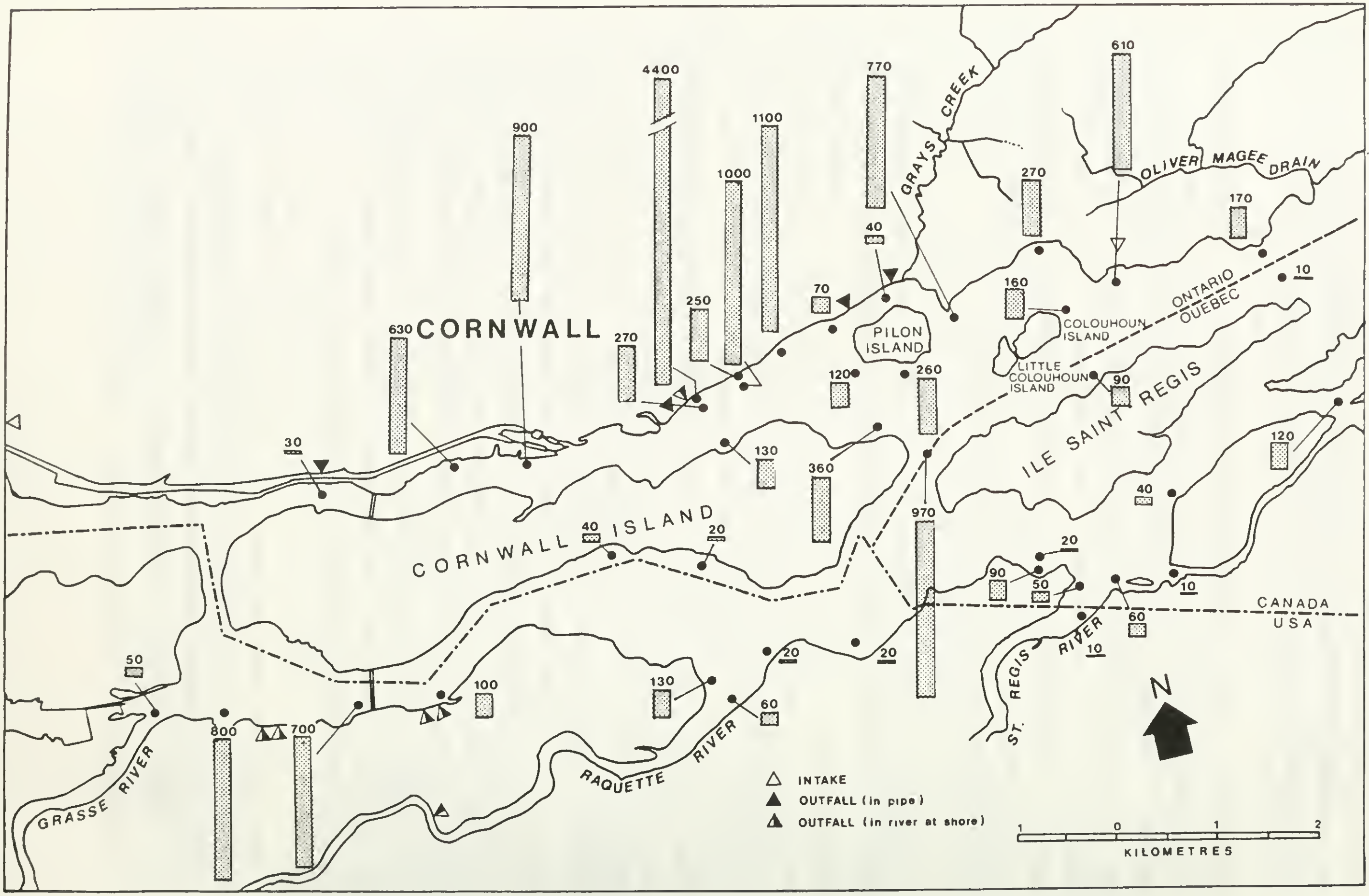

Figure 7 Mercury Levels (ng/g) in Sediment from the Cornwall – Massena Reach of the St. Lawrence River, 1985

TABLE 4

COMPARISON OF SEDIMENT MERCURY CONCENTRATIONS (µg/g)

ALONG THE NORTH SHORE OF THE ST. LAWRENCE RIVER

Area/Location	1970	1975	1979	1985
Upstream of Cornwall	0.20 (0.06-0.29)	0.04 (0.02-0.09)	0.09 (0.06-0.12)	*0.03
0-1.4 km downstream of CIL	4.7 (0.85-14.50)	5.69 (0.05-18.2)	6.80 (1.50-19.8)	*0.63
3-5 km downstream of CIL (in vicinty of Courtaulds (BCL)	14.23 (1.24-35.85)	9.51 (0.62-44.0)	5.40 (0.13-18.0)	1.19 (0.13-4.40)
6-14 km downstream of CIL (area around and downsream of Pilon Island	5.87 (4.00-7.74)	1.87 (0.20-5.87)	0.68 (0.16-1.80)	0.30 (0.01-0.97)

Values are means of samples in each area
(range of values in brackets)

Stations (1985)

Upstream of Cornwall	362
0-1.4 km downstream	365
3-5 km downstream	368, 369, 370
6-14 km downstream	371, 372, 373, 374, 375, 376

* only 1 sample analyzed.
Source of 1970-1979 data: Kauss *et al.*, 1988.

stations 371A and 374A, however, must be made with caution. Due to the high sand content a 371A (95%) and 374A (97%), the estimated concentration may be subject to a large error factor when the extrapolation of the percentage of particles to 100% is done. As well, the relationship between fine particles and contaminant concentration may not be linear at high sand percentages.

Concentrations of lead, mercury and zinc did not correlate well with percentage of fine particles. However, when values for station 368 (where the highest concentrations for most inorganics were observed were deleted from the data set, the linear correlation between percentage fine particles and lead was significant ($r>0.85$; $p<0.05$) while the correlations for mercury and zinc increased to a lesser extent (Table XI). The initial poor correlations and subsequent improved correlations for these parameters with the percentage of fine sediment suggests that a local source, Courtaulds/BCL is contributing to contamination of lead, mercury and zinc in sediment from the Cornwall area. The local influence on these parameters is shown in Figures 9 and 10 where the levels in the corrected sediment results remain most elevated at station 368 in the vicinity of Courtaulds/BCL outfall for lead and zinc, and at station 368 and 366 (below Domtar/CIL/Cornwall Chemicals) for mercury.

The effluent, water and benthic sampling also conducted in 1985 supports that Courtaulds/BCL may be a local source of lead, mercury and zinc which is causing a negative impact on the local benthic community. Concentrations of these parameters detected in Courtaulds/BCL effluent were elevated above levels detected in Courtaulds' intake (Appendix Table II). Similarly, concentrations of mercury in Domtar/CIL/Cornwall Chemicals effluent were elevated above levels detected in intake water. The PWQO for zinc (the only inorganic parameter measured in water in the survey) was exceeded in 32% of the samples collected near Courtaulds/BCL (Table 2). At stations 368 and 368A, insects were absent, except for chironomids, and snails were poorly represented in comparison to other nearby stations, suggesting that the effluent from Courtaulds/BCL may be contributing to local environmental degradation (Griffiths, 1988).

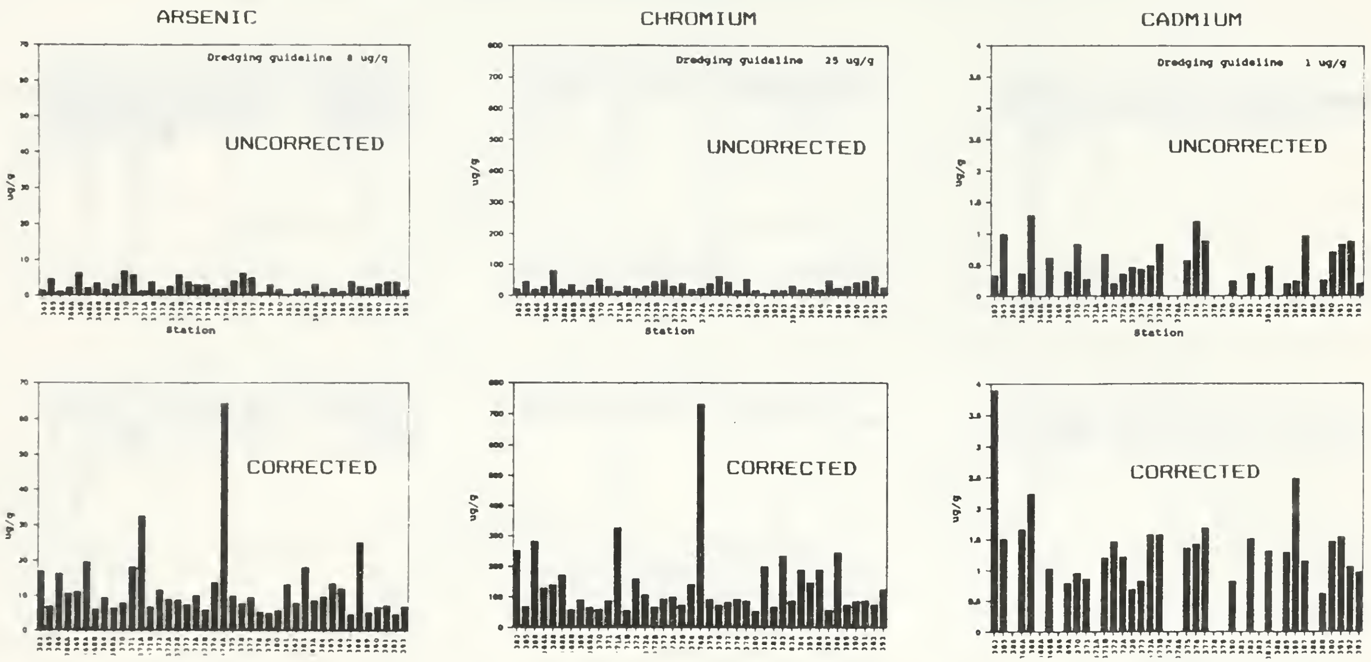

Figure 8: Arsenic, Chromium and Cadmium Sediment Results Uncorrected and Corrected for Particle Size

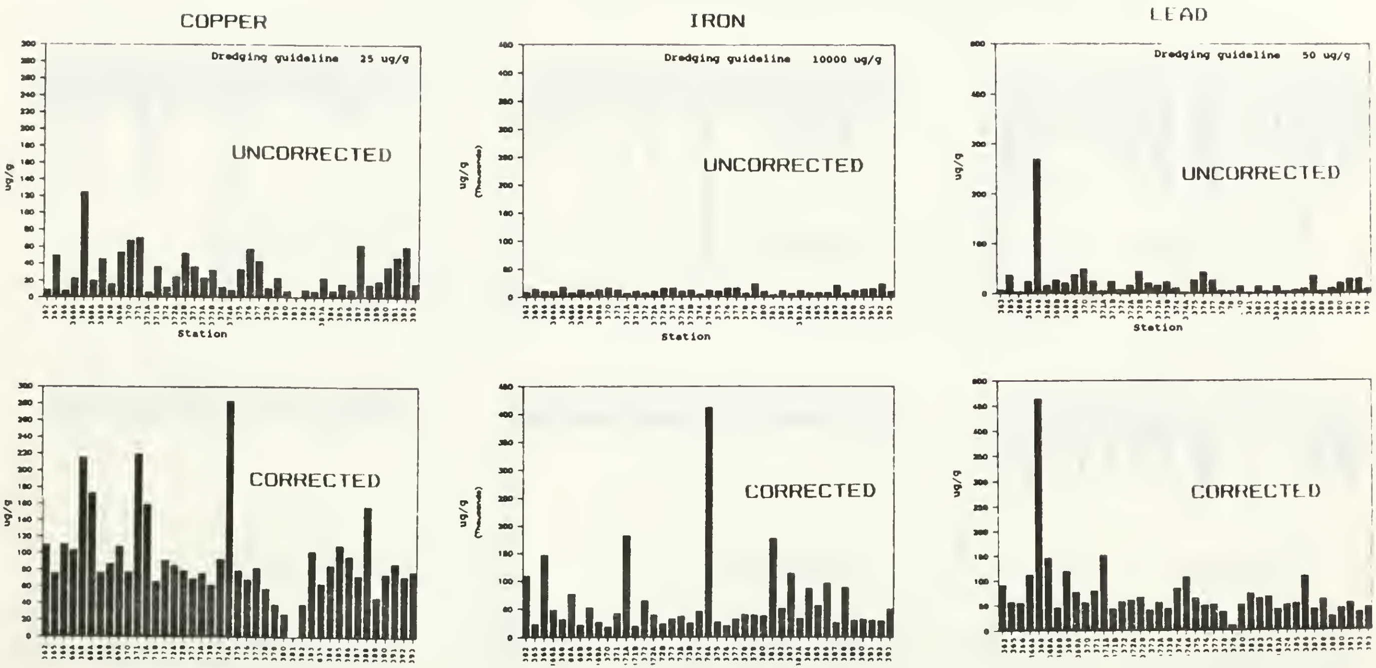

Figure 9: Copper, Iron and Lead Sediment Results Uncorrected and Corrected for Particle Size

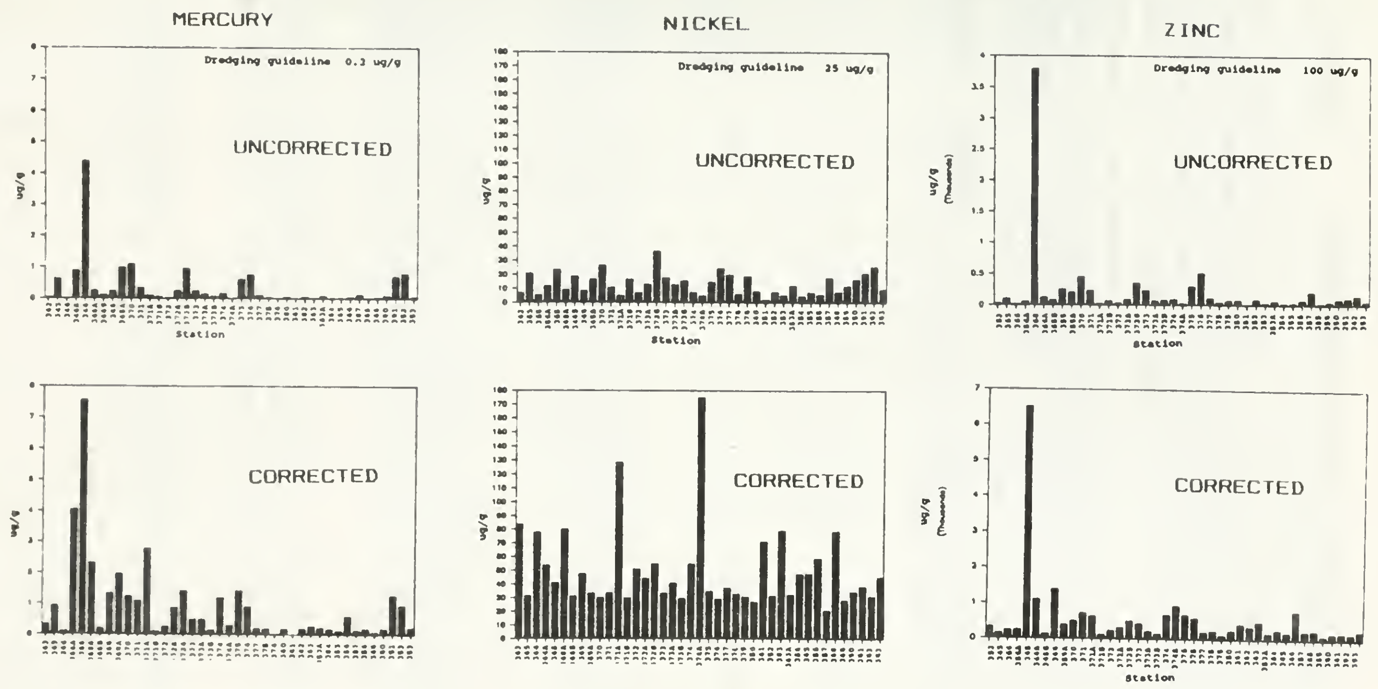

Figure 10: Mercury, Nickel and Zinc Sediment Results Uncorrected and Corrected for Particle Size

4.3.2.5 Comparison between 1979 and 1985 Results

A paired difference test was used to compare the 1979 sediment results to the 1985 results. For each of the parameters considered (particle size, total PCBs, iron, zinc, mercury, cadmium, copper, lead, TP and TKN), the distribution of differences was symmetric about zero. In other words, there was no significant decrease in bulk concentrations between 1979 and 1985. It should be noted that only 26 out of the 41 stations sampled in 1985 were in locations comparable to those surveyed in 1979 and these stations reflect general ambient conditions including areas within the industrial and municipal effluent plumes. The 26 stations used in the analyses are listed in Appendix Table XII.

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6. APPENDIX

TABLES:

FIGURES:

TABLE I

RESULTS OF ENVIRONMENT ONTARIO SURVEY OF COMBINED DOMTAR-CIL-CORNWALL CHEMICALS EFFLUENT - JUNE 18-20, 1985: HEAVY METALS (mg/L)

METAL (mg/L)	JUNE 18			JUNE 19			JUNE 20		
	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530
Iron	.60	.38	.38	.50	.65	.54	.23	.25	.38
Arsenic	.002	.002	.001	.002	.002	.001	.001	.001	.001
Cadmium	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Chromium	<.01	<0.01	0.013	<.02	0.021	<.02	<.01	<.01	<.01
Copper	.03	.03	.04	.07	.06	.06	.02	.03	.03
Mercury µg/L	1.7	2.2	1.9	3.1	2.4	2.4	1.2	0.9	1.3
Nickel	<.01	<.01	<.01	<.02	<.02	<.02	<.01	<.01	<.01
Lead	<.03	<.03	<.03	<.02	<.02	<.02	<.03	<.03	<.03
Zinc	.039	.035	.037	.071	.066	.071	.097	0.083	0.088

Note: All concentrations in mg/L unless otherwise indicated. The samples are two-hour composites taken during the period shown.

TABLE I

RESULTS OF ENVIRONMENT ONTARIO SURVEY OF COMBINED DOMTAR-CIL- CORNWALL CHEMICALS EFFLUENT (JUNE 18-20, 1985) ORGANIC COMPOUNDS

COMPOUND (µg/L)	JUNE 18			JUNE 19			JUNE 20		
	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530
1,1-Dichloro-ethylene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichloro-methane	ND	ND	ND	ND	ND	ND	ND	ND	ND
TR-1,2-Di-chloroethylene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloro-ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	950	300	280	500	190	210	240	260	240
1,1,1-Tri chloroethane	3	ND	ND	ND	1	ND	ND	2	2
1,2-Dichloro-ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetra-chloride	430	1000	600	390	270	450	320	310	310
Benzene	14	20	23	ND	9	15	13	12	9
1,2-Dichloro-propane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloro-ethylene	ND	ND	ND	ND	ND	ND	ND	ND	1
Bromodi-chloromethane	ND	ND	ND	2	2	3	3	4	3
Toluene	2	ND	16	2	1	1	2	1	2
1,1,2-Trich-loroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorodi-bromomethane	ND	ND	ND	ND	ND	ND	ND	1	ND
Tetrachloro-ethylene	3	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	11	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	2	51	ND	5	2	1	3	2	2
M- & P-Xylenes	3	75	11	11	4	2	3	3	5
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND
O-Xylene	14	40	ND	10	19	12	18	1	1
1,1,2,2,-Tetra-chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichloro-benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichloro-benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2 Dichloro-benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not detected

Note: All results are in micrograms per litre. They were measured by gas chromatography and were not confirmed by mass spectrometer. All samples are two-hour composites, taken during the time period shown.

TABLE I

RESULTS OF ENVIRONMENT ONTARIO SURVEY OF COMBINED-DOMTAR-CIL-CORNWALL CHEMICALS EFFLUENT (JUNE 18-20, 1985) - PHENOLIC COMPOUNDS AND TOTAL PCBs

COMPOUND(ng/L)	JUNE 18			JUNE 19			JUNE 20		
	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530	0830-1030	1100-1300	1330-1530
Total Phenols (μg/L) (4AAP)	2,020	1,980	2,000	1,280	980	1,110	1,420	1,080	1,100
Phenol	250,000	192,188	128,569	212,500	104,168	131,250	100,000	81,250	65,000
Vanilline	ND	ND	ND	ND	ND	ND	ND	ND	ND
Homovanillic Acid	18,500	4,250	3,000	19,500	ND	18,000	3,875	3,250	ND
Guaiacol	300,000	328,125	16,963	189,581	52,081	293,750	366,069	323,125	247,500
Syring-aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aceto-vanillone	20,831	15,625	12,500	ND	ND	46,093	333,931	21,875	15,000
Aceto-syringone	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-xylenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-dichloro-phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-tri-chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
pentachloro-phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-chloro-p-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-tri-chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5,6-tetra-chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,5-tetra chlorphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PCB	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not detected

Note: The samples are two-hour composites taken during the time period shown. All results are in nanograms per litre (ng/L).

TABLE I (Cont'd.)
RESULTS OF ENVIRONMENT ONTARIO SURVEY OF
DOMTAR'S INTAKE (JUNE 18-20, 1985)

PARAMETER	JUNE 18	JUNE 19	JUNE 20
Inorganics (mg/L)			
Iron	.048	.100	.046
Arsenic	.001	<.001	.001
Cadmium	<.002	<.002	<.002
Chromium	<.010	<.02	<.010
Copper	.02	.06	.02
Mercury (μg/L)	.33	.80	-
Nickel	<.010	<.020	<.010
Lead	<.030	<.020	<.030
Zinc	<.010	<.020	<.010
Organics (μg/L)			
Chloroform	0	1	5
Phenolics (ng/L)			
Total Phenols (μg/L)	2.8	.4<T	3.8
Phenol	13	63	11
Vanillin	10	0	0
Guaiacol	0	413	50
Acetovanillone	0	0	10

< Actual result is less than reported value.

NOTE: The samples are seven-hour composites collected between 0830 and 1530. Only detected compounds in the Domtar intake are reported. The detection limit for all organic and phenolic compounds was zero, except for total PCBs which had a 20 ng/L detection limit.

TABLE II

COURTAULDS - BCL EFFLUENT DATA, 1985

Parameter	Units	SEWER		
		Combined Acid	Viscose	Sulphide
Reference 1:				
Flow Rate	IMGPM	572	533	194
	m^3/s	.043	.040	.015
Conductivity	UMHO/cm @ 25°C	19,600	1,650	2,540
Total Hardness	mg/L as $CaCO_3$	80.4	14.1	29.0
Calcium	mg/L as Ca	21.0	4.0	8.5
Magnesium	mg/L as Mg	6.80	1.00	1.90
Sodium	mg/L as Na	1,900	292.0	420.0
Potassium	mg/L as K	2.60	1.30	0.75
Total Alkalinity	mg/L as $CaCO_3$	<.2	463.4	159.2
pH		1.92	11.16	8.64
Total Acidity	mg/L as $CaCO_3$	3,073.0	<.00	<.00
Fluoride	mg/L as F	0.18	0.13	0.01
Chloride	mg/L as Cl	163.4	107.8	560.8
Sulphate	mg/L as SO_4	7,400	230	165
Total Ammonium	mg/L as N	0.10	0.05	0.05
Total Nitrates	mg/L as N	0.30	0.05	0.70
Nitrite	mg/L as N	0.030	0.015	0.005
Dissolved Organic Carbon	mg/L as C	132.0	30.5	43.5
Dissolved Inorganic Carbon	mg/L as C	1.2	27.0	29.6
Aluminum	mg/L as Al	.310	.240	.470
Arsenic	mg/L as As			
Cadmium	mg/L as Cd	<.002	<.0020	<.002
Chromium	mg/L as Cr	0.024	0.130	0.015
Cobalt	mg/L as Co	<.010	<.010	<.010
Copper	mg/L as Cu	0.03	0.02	0.09
Iron	mg/L as Fe	2.40	0.54	1.60
Lead	mg/L as Pb	0.140	0.061	0.100
Manganese	mg/L as Mn	0.320	0.500	0.023
Mercury	µg/L as Hg			
Nickel	mg/L as Ni	0.017	<0.10	<0.010
Zinc	mg/L as Zn	6.100	2.000	0.180
Carbonyl sulphide	µg/L	<2.	7	<2.0
Carbon Disulphide	µg/L	1,400	121	<2.0
Hydrogen Sulphide	µg/L	590	7	<2.0
Benzene	µg/L	0.	4.	0.
Bromodi-chloromethane	µg/L	0.	0.	100.
Carbon Tetra-chloride	µg/L	0.	0.	20.
Chlorodi-bromomethane	µg/L	0.	0.	2.
Chloroform	µg/L	4.	6.	
Dichloromethane	µg/L	57.	0.	0.
Toluene	µg/L	2.	1.	0.

TABLE II (Cont'd)

Parameter	Units	Sewer		
		Combined Acid	Viscose	Sulphide
Reference 2:				
Sulphuric Acid		0.331%		
SS	mg/L	68.0	48.0	17.0
COD	mg/L	512.0	483.0	-
BOD_5	mg/L	49.0	348.0	186.0
Reference 3:				
Carbon Disulphide	µg/L	15,000	9,000	3,200
Hydrogen Sulphide	µg/L	3,100	3,00	15.0
Zinc	mg/L	50.0/60.0		

Note:

Reference 1: MOE - 1985; June 18 sample.

2: Monthly Reports filed by Courtaulds for April, 1985.

3: MOE - 1985

IMGPM - Imperial gallons per minute.

TABLE II (CONT'D.) COURTAULDS EFFLUENT RESULTS - ACID SEWER

	JUNE 19				JUNE 20			
INORGANICS MG/L	COURTAULDS INTAKE	COURTAULDS ACID			COURTAULDS INTAKE	COURTAULDS ACID		
		0900-1100	1130-1330	1400-1600		0900-1100	1130-1330	1400-1600
Iron	.08	3.3	3.6	2.6	<.03	6.9	2.7	2.9
Arsenic	<.001	.002	.001	.001	.001	.003	.002	.002
Cadmium	<.002	<.002	<.002	<.002	<.002	<.0006	<.002	<.002
Chromium	<.02	.045	.037	.033	<.01	.044	.021	.037
Copper	.04	.07	.07	.04	.02	.08	.02	.03
Mercury (µg/L)	.48	6.7	6.6	11.0	.51	14.7	4.3	15.0
Nickel	<.02	.033	.021	.021	<.01	.033	.019	.026
Lead	<.02	.230	.310	.250	<.03	.630	.22	.22
Zinc	.054	23.0	49.0	29.0	.029	53.6	8.4	24.0
ORGANICS UG/L								
1,1-Dichloroethylene	0	0	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0	0	0
TR-1,2-Dichloroethylene	0	0	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0	0	0
Chloroform	2	4	5	3	1	5	31	-
1,1,1-Trichloroethane	0	0	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0	0	0
Carbon Tetrachloride	1	0	0	0	1	0	0	0
Benzene	0	0	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0	0	0
Bromodichloromethane	0	0	0	0	0	0	0	0
Toluene	0	4	4	5	0	3	1	-
1,1,2-Trichloroethane	0	0	0	0	0	0	0	0
Chlorodibromomethane	0	0	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0	0	0
Chlorobenzene	0	0	0	0	0	0	0	0
Ethylbenzene	0	0	0	0	0	0	0	0
M- & P-Xylenes	0	0	0	0	0	0	0	0
Bromoform	0	0	0	1	0	0	0	0
O-Xylene	1	0	0	0	1	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0	0	0

TABLE II (CONT'D.) COURTAULDS EFFLUENT RESULTS - VISCOSE SEWER

	JUNE 19				JUNE 20			
INORGANICS MG/L	COURTAULDS INTAKE	COURTAULDS VISCOSE			COURTAULDS INTAKE	COURTAULDS VISCOSE		
		0900-1100	1130-1330	1400-1600		0830-1030	1100-1300	1330-1530
Iron	.08	.88	.64	1.6	<.03	<.03	.33	.35
Arsenic	<.001	.001	.001	.001	.001	.002	.001	.001
Cadmium	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Chromium	<.02	.08	0.1	.14	<.01	<.01	.11	.11
Copper	.04	.03	<.02	.03	.02	.01	<.01	.01
Mercury (μg/L)	.48	4.7	4.5	11.0	.51	4.9	3.1	3.6
Nickel	<.02	<.02	<.02	<.02	<.01	<.01	<0.01	<.01
Lead	<.02	.083	.077	.170	<.03	<.03	<.03	.047
Zinc	.054	4.1	3.6	4.4	.029	.071	1.9	2.1
ORGANICS UG/L								
1,1-Dichloroethylene	0	0	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0	0	0
TR-1,2-Dichloroethylene	0	0	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0	0	0
Chloroform	2	-	23	-	1	-	920	42
1,1,1-Trichloroethane	0	0	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0	0	0
Carbon Tetrachloride	1	0	0	0	1	0	1	0
Benzene	0	0	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0	0	0
Bromodichloromethane	0	0	0	0	0	0	45	0
Toluene	0	0	0	173	0	2	0	1
1,1,2-Trichloroethane	0	1	0	0	0	0	0	0
Chlorodibromomethane	0	0	0	0	0	0	5	0
Tetrachloroethylene	0	0	0	0	0	0	0	0
Chlorobenzene	0	0	0	0	0	0	0	0
Ethylbenzene	0	0	0	0	0	0	0	0
M- & P-Xylenes	0	0	0	0	0	0	0	0
Bromoform	0	0	0	0	0	0	0	0
O-Xylene	1	0	0	0	1	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0	0	0

TABLE II (CONT'D.) BCL EFFLUENT RESULTS - SULPHIDE SEWER

	JUNE 19				JUNE 20			
INORGANICS MG/L	COURTAULDS INTAKE	BCL SULPHIDE			COURTAULDS INTAKE	BCL SULPHIDE		
		0900-1100	1130-1330	1400-1600		0900-1100	1130-1330	1400-1600
Iron	.08	.53	.32	.71	<.03	.730	.20	.270
Arsenic	<.001	<.001	<.001	.001	.001	.001	.001	.001
Cadmium	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Chromium	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.01
Copper	.04	.04	.03	.09	.02	.05	.04	.04
Mercury (µg/L)	.48	3.60	3.3	5.5	.51	3.3	9.3	2.9
Nickel	<.02	<.02	<.02	<.02	<.01	<.01	<.01	<.01
Lead	<.02	<.02	<.02	.023	<.03	<.03	<.03	<.03
Zinc	.054	.240	.160	.140	.029	.074	.070	.086
ORGANICS UG/L								
1,1-Dichloroethylene	0	0	0	2	0	0	0	0
Dichloromethane	0	0	0	0	0	0	0	0
TR-1,2-Dichloroethylene	0	0	0	0	0	0	0	0
1,1-Dichloroethane	0	0	0	0	0	0	0	0
Chloroform	2	360	400	2420	1	1900	8	990
1,1,1-Trichloroethane	0	0	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0	0	0
Carbon Tetrachloride	1	0	0	3	1	0	1	0
Benzene	0	0	0	0	0	0	0	0
1,2-Dichloropropane	0	0	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0	0	0
Bromodichloromethane	0	9	16	58	0	43	0	42
Toluene	0	0	0	6	0	0	4	0
1,1,2-Trichloroethane	0	0	0	0	0	0	0	0
Chlorodibromomethane	0	0	0	8	0	4	0	5
Tetrachloroethylene	0	0	0	0	0	1	0	0
Chlorobenzene	0	0	0	0	0	0	0	0
Ethylbenzene	0	0	0	0	0	0	0	0
M- & P-Xylenes	0	0	0	0	0	0	0	0
Bromoform	0	0	0	0	0	0	0	0
O-Xylene	1	0	0	2	1	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0	0	0
1,3-Dichlorobenzene	0	0	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0	0	0

TABLE III

1985 CORNWALL WATER QUALITY RESULTS

CONVENTIONALS

Station		Phenols µg/L	Conduct. umho/cm	pH	Temp °C	Fluorides mg/L
361	Max	13.2	320	8.40	14.0	0.12
	Min	1.2	316	8.32	13.3	0.12
	Mean	3.7	318.6	8.37	13.8	0.12
	SD	4.2	1.3	0.03	0.31	0
	N	7	7	7	7	2
361A	Max	7.4	439	8.40	14.2	0.12
	Min	1.0	316	7.77	13.8	0.11
	Mean	3.1	335.7	8.28	13.9	0.115
	SD	2.3	45.6	0.23	0.16	0.01
	N	7	7	7	7	2
361B	Max	5.6	321	8.43	14.1	0.12
	Min	0.8<T	317	8.29	13.8	0.11
	Mean	2.4	318.7	8.36	14.02	0.115
	SD	1.6	1.2	0.06	0.04	0.01
	N	7	7	7	5	2
362	Max	3.4	321	8.41	14	0.12
	Min	0.6<T	316	8.32	14	0.12
	Mean	1.7	318.7	8.38	14	0.12
	SD	0.99	1.5	0.03	0	0
	N	8	8	8	4	3
363	Max	4.4	320	8.45	14.1	0.12
	Min	1.4	318	8.29	14	0.12
	Mean	2.5	318.8	8.38	14.02	0.12
	SD	1.1	0.75	0.05	0.04	0
	N	6	6	6	5	3
364	Max	3.4	439	8.43	14.0	0.12
	Min	1.4	316	7.79	13.5	0.11
	Mean	2.1	335.3	8.29	13.9	0.115
	SD	0.8	45.7	0.22	0.2	0.01
	N	7	7	7	7	2
365	Max	6.8	325	8.42	14.3	0.13
	Min	3.0	318	8.27	14.0	0.12
	Mean	4.2	321.1	8.37	14.1	0.125
	SD	1.6	2.2	0.05	0.12	0.01
	N	7	7	7	7	2
365A	Max	5.8	321	8.41	14.2	0.13
	Min	2.6	318	8.27	13.3	0.12
	Mean	4.4	320.4	8.37	13.96	0.125
	SD	1.02	1.1	0.06	0.30	0.01
	N	7	7	7	7	2
366	Max	1.8	319	8.24	14.1	0.12
	Min	0.8<T	318	8.22	14.0	0.12
	Mean	1.3	318.5	8.23	14.05	0.12
	SD	0.71	0.71	0.01	0.07	0
	N	2	2	2	2	2

TABLE III (Cont'd.)
1985 CORNWALL WATER QUALITY RESULTS
CONVENTIONALS

		Phenols µg/L	Conduct. umho/cm	pH	Temp °C	Fluorides mg/L	Sulphates mg/L	Zinc mg/L
366A	Max	21.6	319	8.31	14.2	0.13		
	Min	0.8<T	316	8.28	14.1	0.12		
	Mean	11.2	317.5	8.295	14.15	0.125		
	SD	14.7	2.1	0.02	0.07	0.01		
	N	2	2	2	2	2		
366B	Max	24.2	320	8.34	14.2	0.13		
	Min	1.8	318	8.34	14.1	0.12		
	Mean	13.0	319	8.34	14.15	0.125		
	SD	15.8	1.4	0	0.07	0.01		
	N	2	2	2	2	2		
367	Max	8.2	447	8.42	14.9	0.14	107.86	0.110
	Min	2.4	317	7.77	14.2	0.12	26.15	0.002
	Mean	4.3	330	8.28	14.4	0.13	34.7	0.030
	SD	1.3	25.9	0.13	0.2	0.01	19.7	0.031
	N	27	27	27	24	9	18	18
368	Max	4.8	319	8.36	14.5	0.14	26.45	0.038
	Min	2.6	317	8.01	14.2	0.12	25.50	0.001
	Mean	3.15	317.75	8.28	14.3	0.13	26.04	0.011
	SD	0.7	0.9	0.11	0.1	0.01	0.41	0.014
	N	8	8	8	8	2	6	6
368A	Max	4.4	338	8.36	14.8	0.14	35.40	0.140
	Min	2.6	323	8.13	14.2	0.14	28.50	0.022
	Mean	3.6	327.6	8.26	14.4	0.14	30.57	0.075
	SD	0.6	4.6	0.10	0.19	0	2.51	0.041
	N	8	8	8	8	2	6	6
368B	Max	6.6	350	8.37	14.9	0.14	42.50	0.440
	Min	3.0	320	7.97	14.3	0.14	29.45	0.062
	Mean	3.8	336.75	8.23	14.6	0.14	35.73	0.229
	SD	1.2	10.7	0.14	0.28	0	4.53	0.145
	N	8	8	8	8	2	6	6
369	Max	3.6	318	8.42	14.3		26.35	0.017
	Min	2.4	316	8.28	14.3		25.75	0.001
	Mean	2.97	317.2	8.36	14.3		26.07	0.006
	SD	0.5	0.75	0.05	0.		0.20	0.007
	N	6	6	6	6		6	6
369A	Max	4.6	319	8.39	14.5		26.50	0.013
	Min	3.0	317	8.24	14.3		25.40	0.002
	Mean	3.6	317.8	8.33	14.35		25.87	0.007
	SD	0.6	0.7	0.05	0.08		0.42	0.005
	N	6	6	6	6		6	6
369B	Max	9.4	322	8.39	14.3	0.14	27.0	0.020
	Min	2.4	317	8.25	14.2	0.12	25.25	0.012
	Mean	3.95	319.25	8.31	14.2	0.13	26.4	0.016
	SD	1.8	1.8	0.05	0.05	.007	0.62	0.003
	N	12	12	12	12	6	6	6

TABLE III (Cont'd).
1985 CORNWALL WATER QUALITY RESULTS
CONVENTIONALS

		Phenols µg/L	Conduct. umho/cm	pH	Fluorides mg/L
370	Max	18.0	317	8.37	0.13
	Min	1.8	316	8.30	0.13
	Mean	9.9	316.5	8.33	0.13
	SD	11.5	0.7	0.05	0
	N	2	2	2	2
370A	Max	3.8	322	8.26	0.13
	Min	3.0	320	8.25	0.12
	Mean	3.4	321	8.255	0.125
	SD	0.6	1.4	0.01	0.01
	N	2	2	2	2
371	Max	2.4	317	8.36	0.14
	Min	0.8<T	316	8.28	0.13
	Mean	1.6	316.5	8.32	0.135
	SD	1.1	0.7	0.06	0.01
	N	2	2	2	2
371A	Max	9.8	317	8.37	0.13
	Min	2.6	317	8.36	0.12
	Mean	6.2	317	8.365	0.125
	SD	5.1	0	0.01	0.01
	N	2	2	2	2
371B	Max	20.2	321	8.32	0.13
	Min	4.2	319	8.26	0.12
	Mean	12.2	320	8.29	0.125
	SD	11.3	1.41	0.04	0.01
	N	2	2	2	2
372	Max	12.4	318	8.39	0.13
	Min	1.4	315	8.33	0.12
	Mean	6.9	316.5	8.36	0.125
	SD	7.8	2.12	0.04	0.01
	N	2	2	2	2
372A	Max	2.2	319	8.34	0.12
	Min	1.6	319	8.25	0.12
	Mean	1.9	319	8.30	0.12
	SD	0.4	0	0.06	0
	N	2	2	2	2
372B	Max	23.0	322	8.26	0.13
	Min	3.8	320	8.24	0.13
	Mean	13.4	321	8.25	0.13
	SD	13.6	1.4	0.01	0
	N	2	2	2	2
373	Max	2.4	317	8.31	0.13
	Min	2.0	315	8.28	0.13
	Mean	2.2	316.5	8.295	0.13
	SD	0.3	1.4	0.02	0
	N	2	2	2	2

TABLE III (Cont'd).
1985 CORNWALL WATER QUALITY RESULTS
CONVENTIONALS

		Phenols µg/L	Conduct. umho/cm	pH	Temp °C	Fluorides mg/L	Sulphates mg/L	Zinc mg/L
373A	Max	2.6	318	8.36		0.12		
	Min	1.6	317	8.31		0.12		
	Mean	2.1	317.5	8.34		0.12		
	SD	0.7	0.7	0.03		0		
	N	2	2	2		2		
373B	Max	10.4	321	8.34		0.14		
	Min	3.6	320	8.22		0.13		
	Mean	7.0	320.5	8.28		0.135		
	SD	4.8	0.7	0.08		0.01		
	N	2	2	2		2		
374	Max	2.8	317	8.31		0.13		
	Min	2.2	316	8.28		0.13		
	Mean	2.5	316.5	8.30		0.13		
	SD	0.4	0.7	0.02		0		
	N	2	2	2		2		
374A	Max	20.2	320	8.30		0.14		
	Min	3.8	319	8.28		0.13		
	Mean	12.0	319.5	8.29		0.135		
	SD	11.6	0.7	0.14		0.01		
	N	2	2	2		2		
394	Max	8.4	342	8.39	14.8	0.13	37.10	0.170
	Min	2.6	318	8.25	14.2	0.12	26.30	0.001
	Mean	4.2	323.5	8.30	14.4	0.125	29.23	0.056
	SD	1.9	8.3	0.05	0.2	0.01	4.5	0.077
	M	8	8	8	8	2	6	6
395	Max	4.8	323	8.41	14	0.13		
	Min	1.0	319	8.32	14	0.12		
	Mean	3.3	320.2	8.38	14	0.125		
	SD	1.6	1.8	0.04	0	0.01		
	N	5	5	5	5	2		
396	Max	3.0	319	8.41	14	0.12		
	Min	1.0	316	8.28	13.6	0.12		
	Mean	1.86	318	8.36	13.9	0.12		
	SD	0.7	1.0	0.05	0.15	0		
	N	7	7	7	7	2		
396A	Max	5.4	322	8.41	14	0.12		
	Min	1.0	318	8.26	13.6	0.12		
	Mean	2.9	319.1	8.37	13.9	0.12		
	SD	1.7	1.9	0.06	0.16	0		
	N	7	7	7	7	2		
397	Max	3.6	319	8.44	14.0	0.13		
	Min	1.4	316	8.28	13.6	0.12		
	Mean	2.1	318.3	8.37	13.9	0.12		
	SD	0.8	1.1	0.05	0.2	0.01		
	N	6	7	7	7	2		

TABLE IV

1985 CORNWALL WATER QUALITY RESULTS - VOLATILES

VOLATILES	PARAMETERS (ug/L)				
Sampling Station Time	TR-1,2-Dichloroethylene	Chloroform	1,1,1-Trichloroethane	Toluene	Tetrachloroethylene
361 0927					
0930	ND	ND	ND	ND	ND
1107	ND	ND	ND	ND	ND
1107	2	11	4	27	3
	2	9	3	23	2
361A 0936					
0936	ND	ND	ND	ND	ND
1117	ND	ND	ND	ND	ND
1117	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
361B 0945					
0945	ND	ND	ND	ND	ND
1127	ND	ND	ND	ND	ND
1177	ND	ND	ND	ND	1
	ND	ND	ND	ND	1
362 0954					
0954	ND	ND	ND	ND	ND
1135	ND	ND	ND	ND	ND
1135	ND	ND	ND	ND	ND
	ND	ND	ND	ND	1
364 0902					
1043	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
365 0838					
1026	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
396 0907					
1055	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
396A 0911					
1057	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
397 0853					
1035	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND
Min Measureable Amount	0.000	0.000	0.000	0.000	0.000

ND - Not Detectable

All samples were collected on June 20, 1985.

Not detected at any of sample stations listed:

1,1 - Dichloroethylene, Dichloromethane
1,1 - Dichloroethane, 1,2-Dichloroethane
Carbon Tetrachloride, Benzene
1,2 - Dichloropropane
Trichloroethylene
Bromodichloromethane
1,1,2 - Trichloroethane
Chlorodibromomethane
Chlorobenzene
Ethylbenzene
M-, and P-xylenes
Bromoform
O-xylene
1,4 - Dichlorobenzene
1,3 - Dichlorobenzene
1,2 - Dichlorobenzene

TABLE V
1985 CORNWALL WATER QUALITY RESULTS
SPECIATED PHENOLICS

Sampling Station Time	PARAMETER (ng/L)			
	Vanillin	Guaiacol	Acetovanillone	Phenol
361				
0927	7	30	7	26
0930	8	43	7	44
1107	ND	42	ND	ND
361A				
0936	8	40	7	69
1117	ND	40	11	4
361B				
0945	ND	40,000	ND	ND
1127	ND	42	10	ND
Minimum Measureable Amount	0.000	0.000	0.000	0.000

Results available for station 361 only
ND - Not detectable
All samples were collected on June 20, 1985.

ND at any site:
Homovanillic Acid
Syringaldehyde
Acetosyringone
2,5-xylenol
p-cresol
M-chloro-p-cresol
2-chlorophenol
4-chlorophenol
2,4,5-trichlorophenol
2,4,6-trichlorophenol
2,3,4,5-tetrachlorophenol
Pentachlorophenol

TABLE VI
CORNWALL WATER QUALITY RESULTS
ORGANO-SULPHUR COMPOUNDS

STATION		CARBON DISULPHIDE ug/L	DIMETHYL SULPHIDE ug/L
367	Max	0.49	0.09
	Min	0.06	ND
	Mean	0.23	<0.05[1]
	S.D.	0.12	<0.03[1]
	N	9	9
368	Max	0.13	ND
	Min	ND	ND
	Mean	<0.07[1]	ND
	S.D.	<0.04[1]	ND
	N	6	6
369	Max	0.15	ND
	Min	ND	ND
	Mean	<0.08[1]	ND
	S.D.	<0.06[1]	ND
	N	3	3
394	Max	0.60	0.06
	Min	0.08	ND
	Mean	0.34	<0.04[1]
	S.D.	0.26	<0.02[1]
	N	3	3

< - Actual value is less than reported value
ND - Not Detectable

1 Mean values and standard deviations were calculated using the minimum reportable amount for ND. The detection limit for all organo-sulphur compounds was 0.03 µg/L. samples were collected on June 18, 1985.

The following compounds were not detected at any of the stations:

Carbonyl Sulphide
Thiophene
Hydrogen Sulphide
Sulphur Dioxide
Methyl Mercaptan
Ethyl Mercaptan
Dimethyl Disulphide

TABLE VII
SEDIMENT PARTICLE SIZE DISTRIBUTION
ST. LAWRENCE RIVER, 1985

STATION	% SAND > 62 µm	% SILT 62 - 3.7 µm	%CLAY < 3.7 µm	TOTAL %
362	88.56	7.63	1.094	97.28
365	32.64	51.64	14.44	98.72
366	91.90	6.12	1.30	99.32
366A	76.43	19.02	3.13	98.58
368	39.68	45.44	12.66	97.78
368A	87.12	9.77	1.78	98.67
368B	37.24	50.1	9.90	97.24
369	75.77	15.76	2.615	94.14
369A	47.7	41.33	9.04	98.07
370	9.38	63.71	24.27	97.36
371	66.4	25.66	6.74	98.8
371A	95.01	3.74	.528	99.28
371B	40.08	46.27	9.85	96.20
372	84.59	12.36	1.89	98.84
372A	68.97	24.99	4.35	98.31
372B	30.38	54.29	12.89	97.56
373	45.75	40.85	12.28	98.88
373A	66.54	26.02	5.66	98.22
373B	43.99	45.65	7.593	97.23
374	84.51	11.80	2.23	98.54
374A	96.54	2.62	.52	99.68
375	55.94	33.55	8.98	98.47
376	3.6	62.79	20.98	87.37
377	43.33	44.36	8.84	96.53
378	79.98	16.78	2.15	98.91
379	36.98	37.68	23.77	98.43
380	67.11	25.76	4.68	97.55
381	96.56	2.54	0.546	99.65
382	74.47	21.25	3.21	98.93
383	92.13	6.20	1.01	99.34
383A	58.48	30.16	7.06	95.70
384	88.21	9.12	1.43	98.76
385	83.53	12.17	3.32	99.02
386	89.13	7.92	2.10	99.15
387	12.094	69.94	14.87	96.90
388	88.72	8.27	1.87	98.86
389	56.24	35.97	5.83	98.04
390	45.43	39.41	9.52	94.36
391	44.30	42.62	11.61	98.53
392	14.85	60.71	22.43	97.98
393	77.35	17.79	3.75	98.89

TABLE VIII
1985 CORNWALL SEDIMENT RESULTS
NUTRIENTS AND OILS AND GREASES

STATION NORTH CHANNEL	TOTAL PHOSPHORUS mg/g	TOTAL KJELDAHL NITROGEN mg/g	OILS AND GREASES µg/g
362	0.67	0.6	425
365	0.86	3.6	3244
366	0.43	0.4	306
366A	0.70	1.5	2940
368	1.02	4.1	16748
368A	0.56	0.5	749
368B	0.87	3.1	2781
369	0.60	0.6	1578
369A	0.94	2.3	1806
370	1.09	4.7	5893
371	0.91	2.5	4483
371A	0.75	0.5	1604
371B	0.83	3.1	1772
372	0.71	1.1	857
372A	0.82	1.8	2227
372B	0.92	3.5	4014
376	0.98	5.1	6086
373	0.77	2.0	1857
373A	0.88	2.4	2342
373B	0.88	2.5	1619
375	0.73	2.4	2689
374	0.63	0.9	828
374A	0.48	0.8	256

TABLE VIII (Cont'd).
1985 CORNWALL SEDIMENT RESULTS
NUTRIENTS AND OILS AND GREASES

STATION SOUTH CHANNEL	TOTAL PHOSPHORUS	TOTAL KJELDAHL NITROGEN	OILS AND GREASES µg/g
	mg/g	mg/g	
393	0.66	1.1	695
392	1.12	2.7	1543
391	0.95	2.6	2392
390	0.88	2.1	1334
389	0.76	1.0	605
388	0.51	0.5	5479
387	1.10	3.0	1729
386	0.41	0.6	575
385	0.40	0.8	2725
384	0.41	0.5	328
383	0.41	0.5	1355
383A	1.10	0.67	1036
382	0.62	1.6	672
381	0.24	0.2	106
380	0.49	1.6	962
379	0.78	0.6	12
378	0.53	0.7	492
377	0.77	2.8	1988
N	41	41	41
Guideline	1.0	2.0	1500
#>G	4	17	23
%>G	10	41	56
Max	1.12	5.1	16748
Min	0.24	0.2	12
Mean	0.72	1.8	2223
S.D.	0.22	1.27	2786

TABLE IX

1985 CORNWALL SEDIMENT QUALITY RESULTS: ORGANIC COMPOUNDS (ng/g)

SAMPLE STATION DATE, TIME (Y,M,D)	PCB TOTAL	HEXACHLORO-BENZENE	ALDRIN	PP-DDE	DMDT	HEPTACHLOR EPOXIDE	ENDO-SULFAN I	DIELDRIN	ENDO-SULFAN II	PP-DDD	PP-DDT	ENDRIN	α-CHLORDANE	γ-CHLORDANE	Endo-sulphan Sulphate
362 850706 0815	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
365 850706 0930	260	ND	ND	6	ND	10	ND	ND	ND	ND	ND	ND	12	12	ND
366 850706 1010					Undetermined Interference - unable to quantify sample										
366A 850706 1130	60	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	22
368 850709 0815	1010	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
368A 850709 0930	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
368B 850709 1015	45	ND	ND	2	ND	9	ND	ND	ND	ND	ND	ND	ND	ND	ND
369 850710 0810	85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
369A 850710 1000	265	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
370 850710 1050	245	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
371 850712 0730	60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
371A 850711 0800	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
371B 850712 0815	40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
372 850703 0935	ND	ND	ND	ND	ND	ND	ND	18	ND	ND	ND	ND	ND	ND	ND
372A 850703 1130	75	6	5	6	9	ND	2	22	4	ND	ND	ND	ND	ND	ND
Detection Limit	20	1	1	1	5	1	2	2	4	5	5	4	2	2	4

Not Detected (ND) for any sample listed: detection limit (ng/g)

Heptachlor	1	G-BHC Hexachlorocyclohex	1	A-BHC Hexachlorocyclohex	1	op-DDT	5
Mirex	5	Oxychlordane	2	B- " "	1		

TABLE IX (Cont'd.)

1985 CORNWALL SEDIMENT QUALITY RESULTS: ORGANIC COMPOUNDS (ng/g)

SAMPLE STATION DATE, TIME (Y,M,D)	PCB TOTAL	HEXACHLORO-BENZENE	ALDRIN	PP-DDE	DMDT	HEPTACHLOR EPOXIDE	ENDO-SULFAN I	DIELDRIN	ENDO-SULFAN II	PP-DDD	PP-DDT	ENDRIN	α-CHLOR DANE	γ-CHLOR DANE	Endo-sulphen Sulphate
372B 850712 0930	75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
373 850702 0815	ND	8	15	2	ND	5	3	13	ND	ND	ND	ND	ND	ND	ND
373A 850702 0940	55	14	5	2	ND	ND	ND	20	10	ND	ND	ND	ND	ND	ND
373B 850702 1040	95	2	ND	1	ND	ND	ND	18	ND	ND	ND	ND	ND	ND	ND
374 850701 0940	ND	ND	ND	ND	ND	ND	ND	27	ND	ND	ND	ND	ND	ND	ND
374A 850701 1040	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	ND	ND
375 850701 1100	85	9	15	1	6	ND	3	11	ND	ND	ND	ND	ND	ND	ND
376 850703 0835	85	14	33	1	10	ND	4	9	ND	ND	ND	ND	ND	ND	ND
377 850704 1020	1105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
378 850704 0930	40	ND	ND	2	ND	ND	ND	22	ND	ND	ND	ND	ND	ND	ND
379 850704 0830	ND	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	ND	ND	ND	ND
380 850711 1030	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
381 850711 0905	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
382 850711 0947	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Detection Limit	20	1	1	1	5	1	2	2	4	5	5	4	2	2	4

NOTE: See previous page for list of substances not detected in these samples.

TABLE IX (Cont'd).

1985 CORNWALL SEDIMENT QUALITY RESULTS: ORGANIC COMPOUNDS (ng/g)

SAMPLE STATION DATE, TIME (Y,M,D)	PCB TOTAL	HEXACHLORO-BENZENE	ALDRIN	PP-DDE	DMDT	HEPTACHLOR EPOXIDE	ENDO-SULFAN I	DIELDRIN	ENDO-SULFAN II	PP-DDD	PP-DDT	ENDRIN	α-CHLOR DANE	γ-CHLOR DANE	Endo-sulphan Sulphate
383 850708 1055	120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
383A 850708 1130	555	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
384 850708 1030	105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9
385 850708 1010	150	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
386 850708 0915	155	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
387 850708 1100	2835	ND	ND	ND	ND	10	ND	ND	ND	ND	ND	ND	ND	ND	ND
388 850707 1100	ND	ND	ND	ND	ND	ND	ND	22	ND	ND	ND	ND	ND	ND	ND
389 850707 0930	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
390 850707 0815	13750	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
391 850705 0830	2880	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
392 850705 0915	2325	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
393 850705 1030	1650	ND	ND	ND	ND	ND	ND	ND	ND	6	9	ND	ND	ND	ND
Detection Limit	20	1	1	1	5	1	2	2	4	5	5	4	2	2	4

*NOTE: See previous page for list of substances not detected in these samples.

TABLE X

1985 CORNWALL SEDIMENT QUALITY RESULTS: INORGANIC COMPOUNDS

	PARAMETER (µg/g dry weight)								
STATION NORTH CHANNEL	ARSENIC	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	MERCURY	NICKEL	ZINC
362	1.48	0.34	22.0	9.60	9600	8.0	0.03	7.30	30.00
365	4.67	1.00	47.00	50.00	16,000	38.00	0.63	21.00	110.00
366	1.21	<.20	21.00	8.20	11,000	4.10	0.01	5.80	19.0
366A	2.37	0.37	29.00	23.00	11,000	25.00	0.90	12.00	58.00
368	6.52	1.30*	82.00*	125.00*	19,000*	270.00*	4.40*	24.00*	3800.00*
368A	2.28	<.20	20.00*	20.00*	9,000*	17.00	0.27	9.30*	130.00*
368B	3.70	0.62	36.00	46.00	14,000	28.00	0.13	19.00	88.00
369	1.75	<.20	17.00	16.00	9,800	22.00	0.25	8.80	260.00
369A	3.26	0.40	34.00	54.00	14,000	39.00	1.00*	17.00	210.00
370	6.96	0.84	54.00	68.00*	18,000	50.00	1.10*	27.00	460.00
371	5.91	0.28	29.00	71.00*	14,000	26.00	0.36	11.00	240.00
371A	1.39	<.20	14.00	6.80	7800	6.5	0.12	5.50	28.00
371B	3.88	0.68	32.00	37.00	12,000	25.00	0.07	17.00	74.00
372	1.66	0.21	23.00	13.00	9,400	8.40	0.04	7.3	36.00
372A	2.64	0.36	32.00	25.00	12,000	18.0	0.26	13.0	99.0
372B	5.91	0.47	46.00	53.00	17,000	45.0	0.97	37.0	360.0
376	6.52	1.20	63.00	58.00	18,000	43.0	0.77	25.0	520.0
373	3.97	0.44	51.0	37.0	18,000	22.0	0.27	18.0	240.0
373A	3.17	0.50	32.0	24.0	12,000	18.0	0.16	13.0	75.0
373B	3.17	0.84	40.0	33.0	14,000	24.0	0.09	16.0	88.0
375	4.23	0.58*	40.0*	34.0*	12,000	28.0*	0.61	15.0*	300.00
374	1.93	<.20	20.0	13.0	6,600	12.00	0.17	7.7	98.0
374A	2.02	<.20	23.0	8.9	13,000	3.4	0.01	5.5	30.0

* - Reported result verified by re-analysis

< - Value is less than reported; mean calculations assumed < values to equal zero.

TABLE X (Cont'd.)

1985 CORNWALL SEDIMENT QUALITY RESULTS: INORGANIC COMPOUNDS

STATION SOUTH CHANNEL	PARAMETER (µg/g dry weight)								
	ARSENIC	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	MERCURY	NICKEL	ZINC
393	1.48	0.21	27.0	17.0	11,000	10.0	0.05	9.8	58.0
392	3.97	0.89	64.0*	61.0	25,000	31.0	0.80	26.0	150.0
391	3.97	0.84	48.0	48.0	17,000	30.0	0.70	21.0	110.0
390	3.40	0.72	43.0	37.0	16,000	22.0	0.10	17.0	94.0
389	2.19	0.26	32.0	20.0	13,000	12.0	0.04	12.0	50.00
388	2.55	<.20	25.0	16.0	9,100	6.3	0.02	8.0	28.0
387	4.06	0.98	50.0	63.0	23,000*	37.0	0.13	18.0	210.0
386	1.21	0.25	19.0	9.7	9,800	11.0	0.06	5.9	82.0
385	2.10	0.20	23.0	17.0	8,900	8.5	0.02	7.4	32.0
384	1.03	<.20	20.0	9.1	9,300	5.5	0.02	5.0	30.0
383	1.3	<.20	17.0	7.4	8,300	4.9	0.02	5.7	37.0
383A	3.26	0.49	33.0	24.0	13,000	16.0	0.09	12.0	73.0
382	1.93	0.37	17.0	9.5	13,000	16.0	0.05	7.8	92.0
381	0.41	<.20	6.2	<2.0	5,500	2.3	0.01	2.2	14.0
380	1.93	0.37	17.0	9.5	12,000	16.0	0.05	7.8	92.0
379	3.08	<.20	55.0	24.0	25,000*	6.5	0.01	19.0	79.0
378	1.03	<.20	18.0	11.0	7,900	7.1	0.04	6.3	48.0
377	5.11	0.90	45.0	44.0	18,000	28.0	0.12	20.0	120.0
N	41	41	41	41	41	41	41	41	41
Guideline	8.0	1.0	25	25	10,000	50	0.3	25	100
#>G	0	2	24	17	28	1	11	2	15
%>G	0	5	59	41	68	2	27	5	37
Max	6.96	1.30	82	125.00	25,000	270	4.40	37.0	3,800.00
Min	0.41	<.20	6.2	<2.00	5,500	2.3	0.01	2.2	14.0
Mean	3.03	0.41	33.32	30.72	13,220	25.62	0.36	13.5	213.20
S.D.	1.68	0.37	16.18	24.74	4669	4.09	0.72	7.58	585.99
S.E.	0.26	0.06	2.53	3.86	729	6.42	0.11	1.18	91.52

< - value is less than reported; mean calculations assumed
<values to equal zero

KP/sw

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TABLE XI
COEFFICIENTS OF CORRELATION AND DETERMINATION FOR THE PERCENTAGE OF FINE SEDIMENTS VS. THE CONCENTRATION OF INORGANIC PARAMETERS

Inorganic Parameter	n	Coefficient of Correlation (r)	Coefficient of Determination (r^2)
Arsenic	41 40	.83 .84	.69 .71
Cadmium	41 40	.82 .84	.67 .71
Chromium	41 40	.86 .92	.75 .85
Copper	41 40	.77 .88	.60 .76
Iron	41 40	.86 .86	.74 .74
Lead	41 40	.40 .85	.16 .73
Mercury	41 40	.40 .60	.16 .36
Nickel	41 40	.88 .88	.77 .77
Zinc	41 40	.26 .66	.07 .44

Note: Chemical results for station 368 were deleted for calculations where n is 40.

TABLE XII

COMPARABLE SEDIMENT SAMPLING LOCATIONS IN CORNWALL

1979	1985
103	365
100	366A
94	368
90	369
89	370
88	371
93	371B
92	372A
91	372B
63	375
71	376
64	378
65	379
66	380
67	381
69	382
70	383
72	384
76	386
77	387
80	388
81	389
82	390
83	391
84	392
85	393

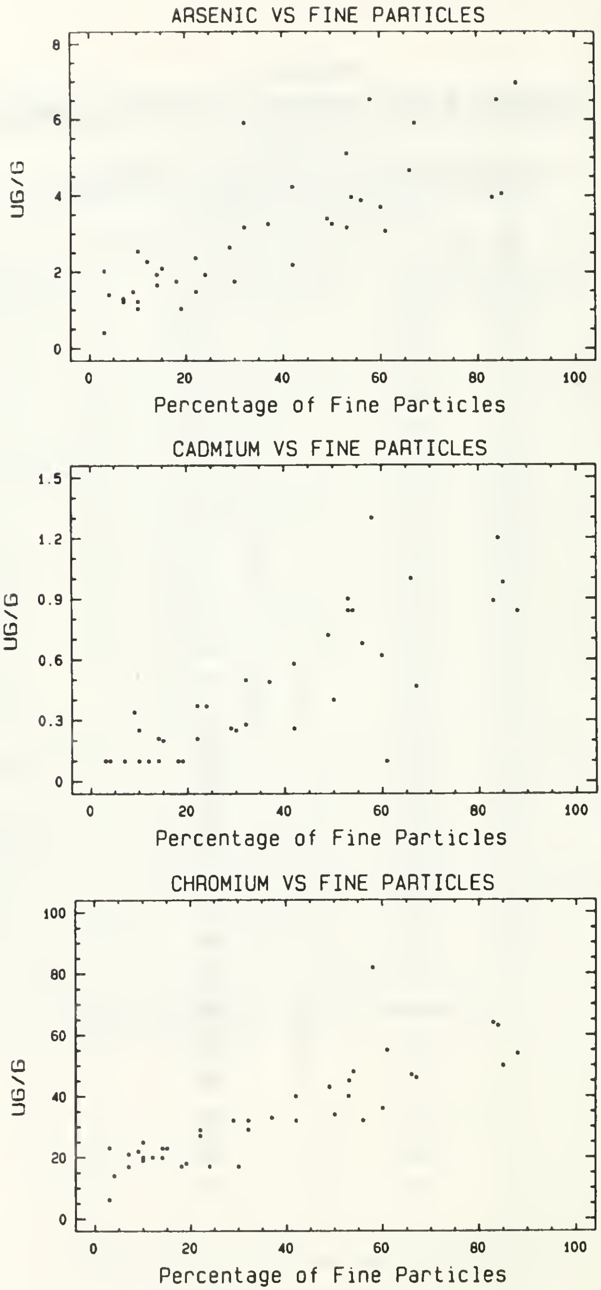

Figure I: Scatterplot of Percentage of Fine Particles vs. Concentration of Arsenic, Cadmium and Chromium

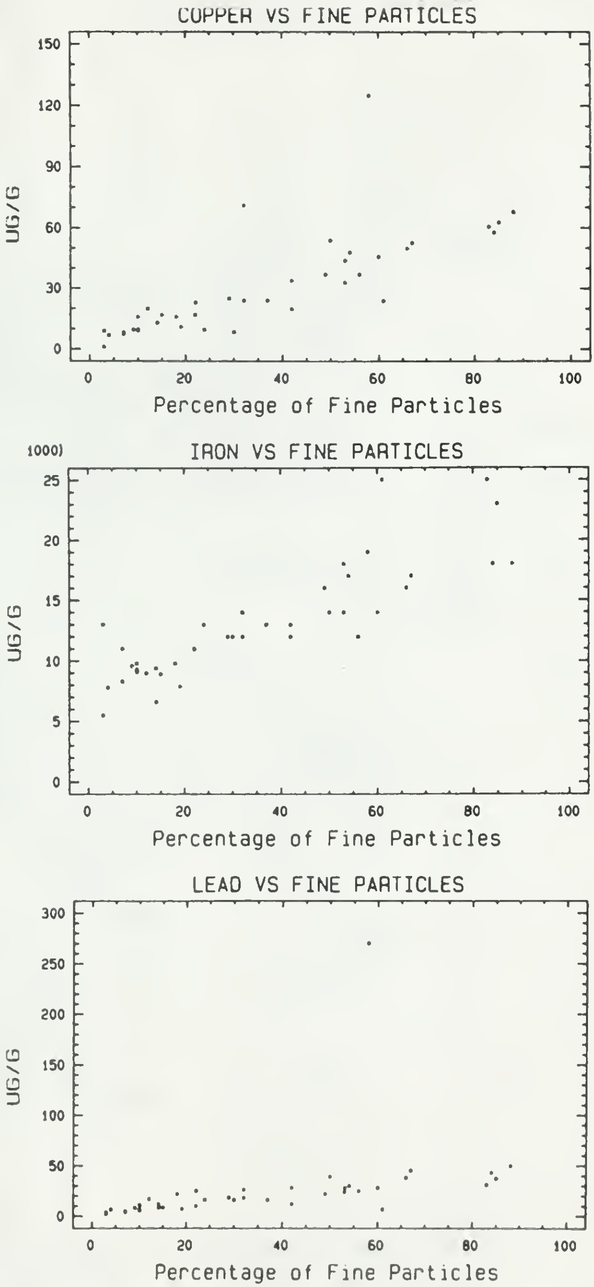

Figure II: Scatterplot of Percentage of Fine Particles vs. Concentration of Copper, Iron and Lead

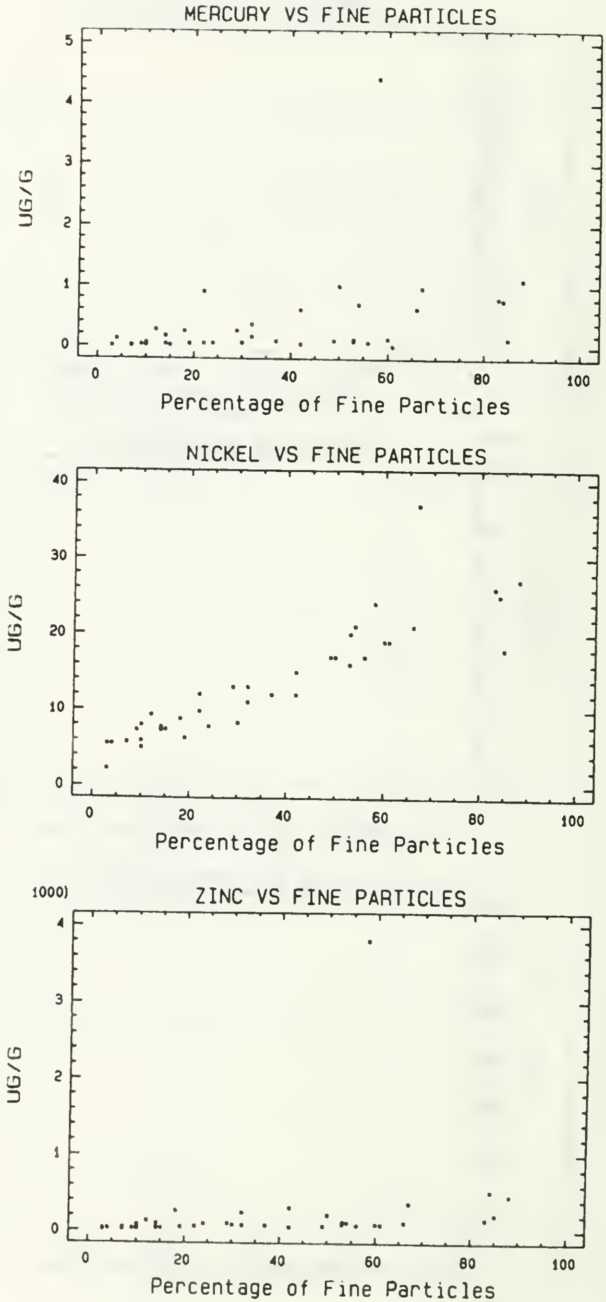

Figure III: Scatterplot of Percentage of Fine Particles vs. Concentration of Mercury, Nickel and Zinc